Home Lab 2 Explained

Electronic Circuits

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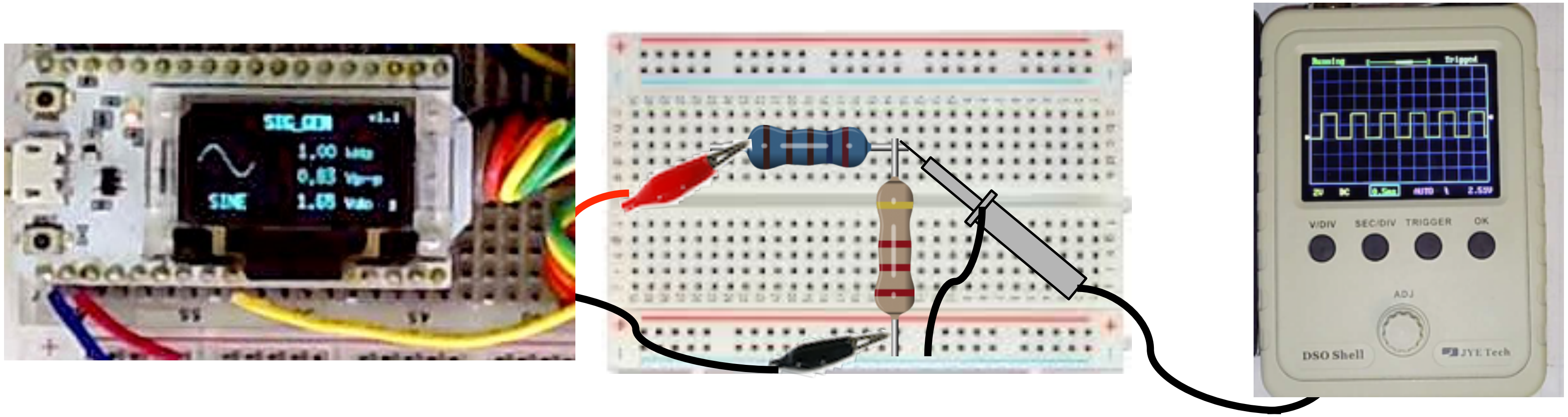
Experimental Setup



- You will be using the function generator to produce a digital waveform or a sine wave as the voltage source at different frequencies to drive your circuits.
- You will build your circuits on the breadboard.
- You will measure the voltages on your circuits using the scope or using a multimeter.
- You may want to use male end of ribbon cable to loosen contacts before inserting a component or a hookup wire.

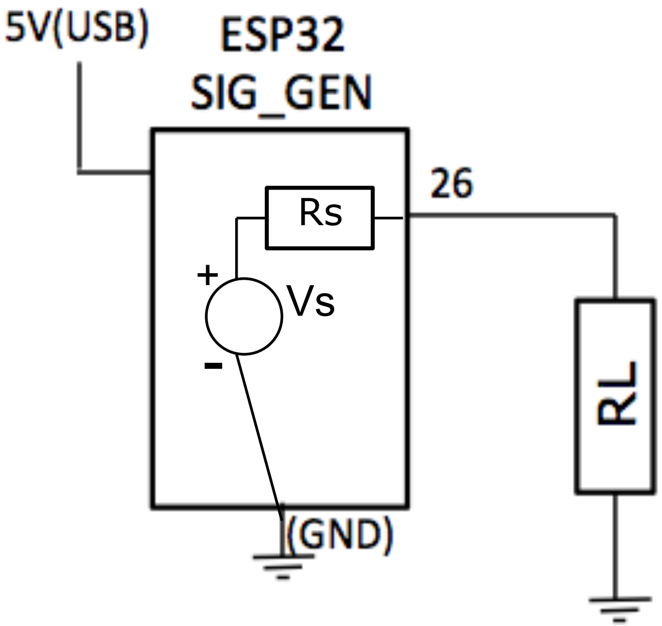
Task 1: Calibrating the DC voltage source

- Analogue signals: DC, SINE, Exponential, NOISY
- Digital signals: CLOCK, PWM, UARTModern digital circuits use lower voltages. We will be using digital circuits operating at 3.3v level.
- In Task 1, you calibrate the DC source by finding out the measured voltage vs the voltage settings:

Voltage Setting	3.0V	2.5V	2.0V	1.5V	1.0V	0.5V
Measured voltage	2.86					
Error in % FS	-4%					

Measured voltage	3.0V	2.5V	2.0V	1.5V	1.0V	0.5V
Voltage Setting	3.18					

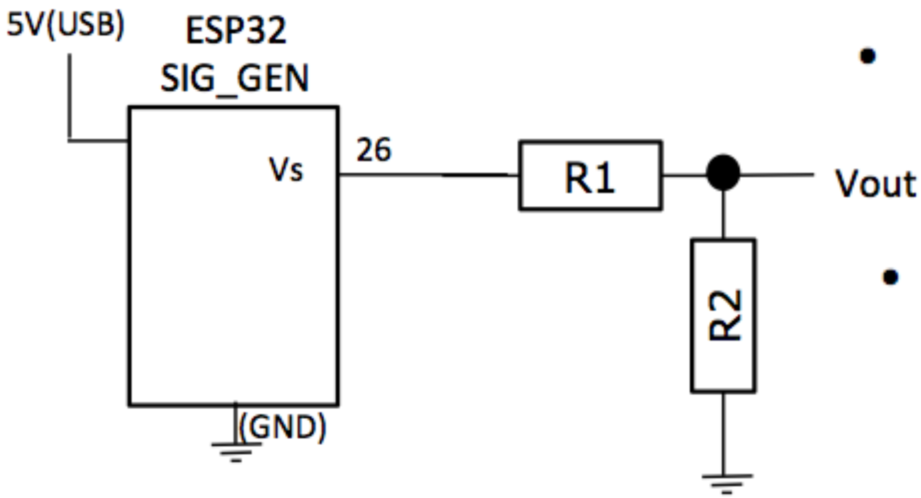
Task 2: Source resistance



Vs (measured)	V setting	10k	1k	100	68
3.0	3.18				1.93
2.0	2.09				1.7
1.0	1.02				1.0

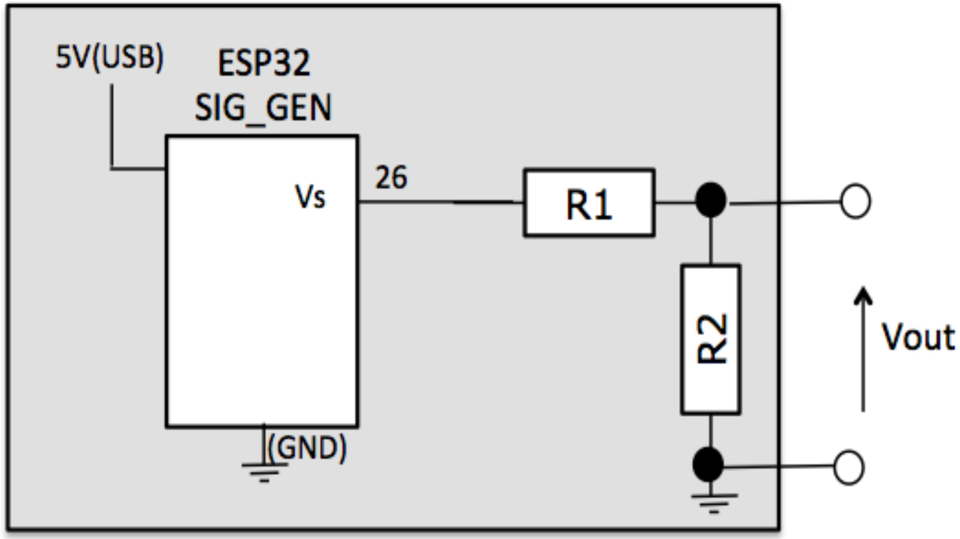
Vs	$V_{measured}$	I_{out}	Rs (Ω)
3.0	1.93	28.4mA	37.7
2.0			
1.0			

Task 3: Voltage Divider Circuit



- Set Vs to 3V. With R1 = R2 = 10k, predict Vout, and confirm with measurement.
  - Substitute R2 with a 20k resistor. What do you expect Vout to be? Confirm with measurement.
- Now apply a sine wave at 1kHz, and the maximum pk-pk voltage from SIG_GEN and measure Vout. Confirm that the voltage divider works for both dc and ac signals.

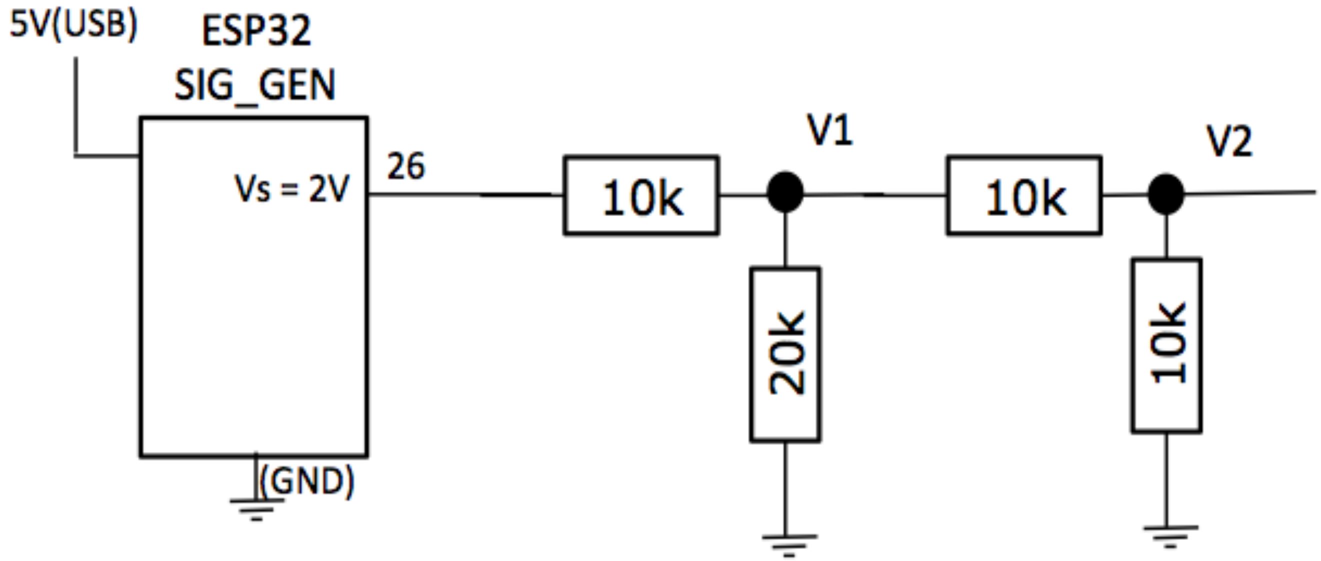
Task 4: Thevenin Equivalent Circuit



- For the circuit shown here, assume that R1 = 10k, R2 = 20k. Derive the Thevenin equivalent network for the circuit inside the grey box. (See below).

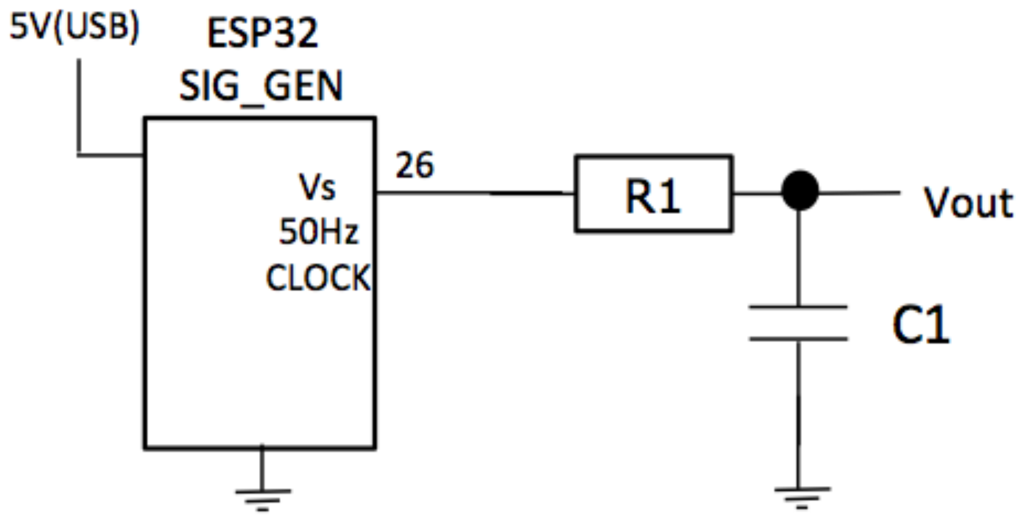
- Set Vs = 2V. Confirm your predication by measuring the Vth as the open-circuit voltage, and work out the value of Rth by measuring the short-circuit current. (Note: your can measure

Task 5: Complex Resistor Network



- With Vs = 2V, measure the value of V1 and V2. Verify this with your calculation to make that this is as you expected.
- The network is the basic for DAC, and is known as a R-2R ladder network. How would you add to this circuit so that a third voltage V3 make sure that this circuit has a third stage and continues the same voltage dividing patent? This would be a good topic for discussion among your team.

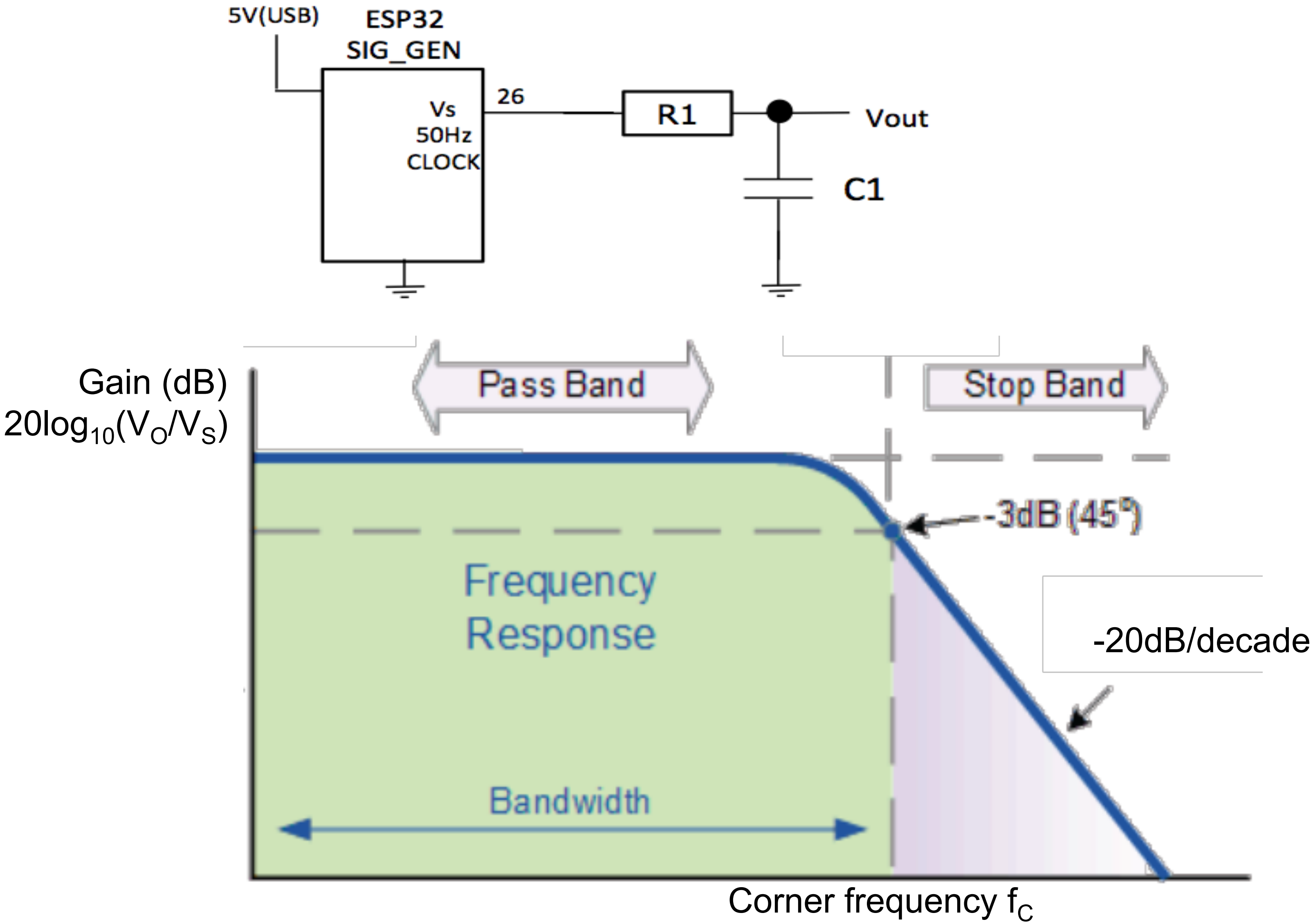
Task 6: RC circuits & Exponential signal



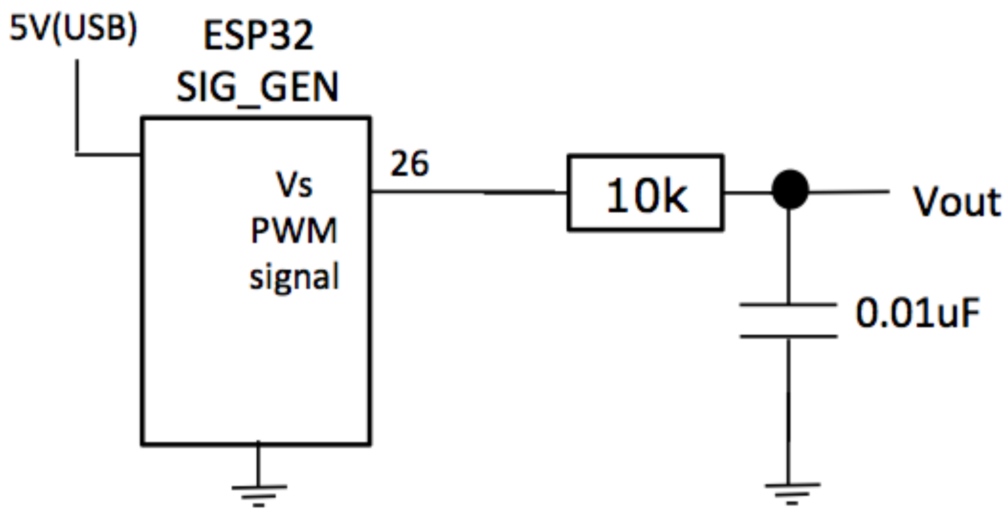
- Construct the following circuit using R1 = 10k and C1 = 0.01uF. Use SIG_GEN to generate a 50Hz CLOCK signal. Measure Vout using the scope. Explain the measured waveform. What is the time constant of this RC network, both in theory and in measurement? You must measure the time-constant both for Vs going from low to high (rising step signal), and from high to low (falling step signal).

- Change R1 = 1k and C1 = 0.1uF, and repeat your measurement. What conclusion can you draw from this?

Task 7: RC circuits – lowpass filter



Task 8: PWM signal & lowpass filter

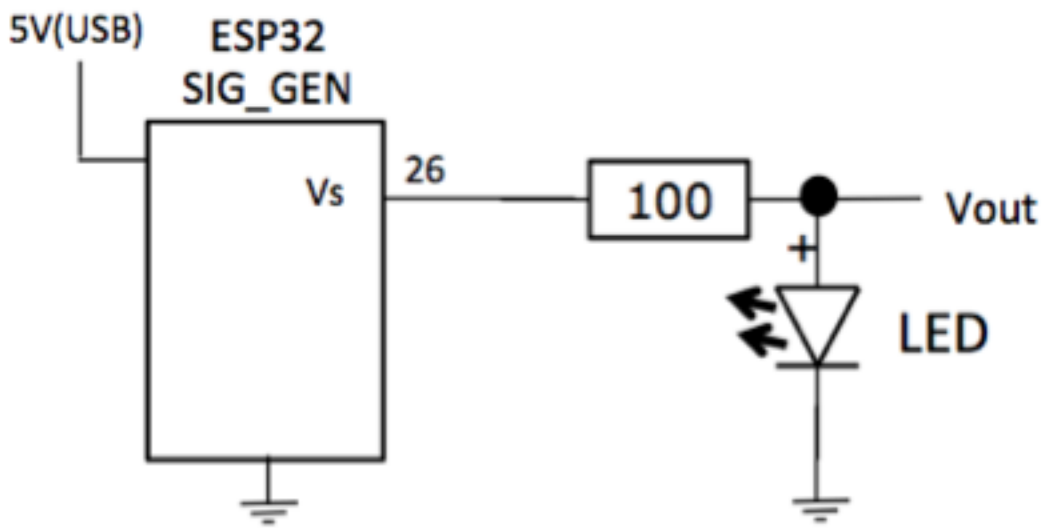


- Select PWM signal at 1kHz and duty cycle of 50% on SIG_GEN, and measure the output of the RC circuit with R1 = 10k, and C1 = 0.01uF.

- Increase the frequency to 10kHz and then 100kHz. Explain your observation of the output voltage.

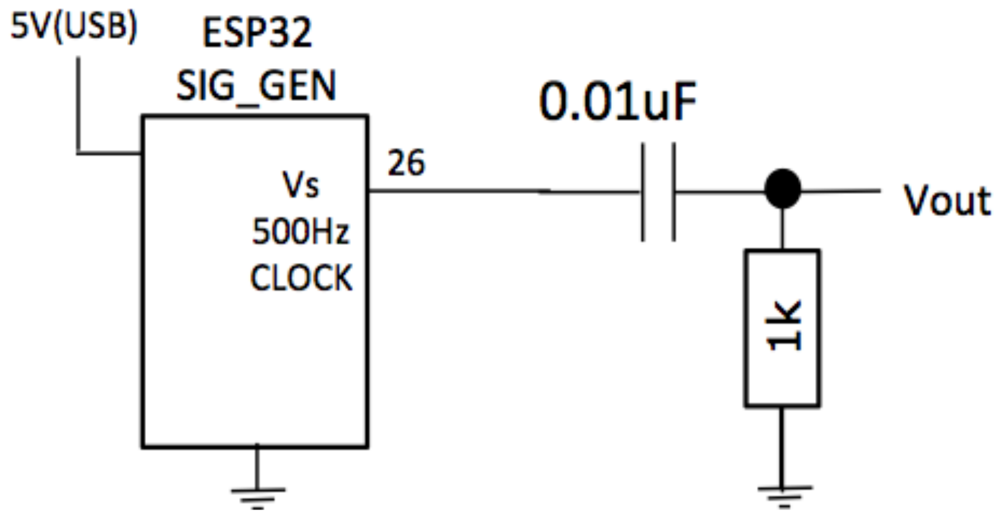
- Using 100kHz PWM signal, adjust the duty cycle from 0% to 100% in steps of 10. Use the multimeter to measure the output voltage. Plot the curve Vout (dc) vs Duty Cycle. Explain the results.

Task 9: PWM & LED brightness



- Set SIG_GEN to provide a DC voltage between 0 to 3.3V. Measure Vout with a multimeter and determine the minimum voltage and current that the LED is lid up.
- Now drive the LED with a PWM signal at, say 10kHz and observe the output light intensity when the duty cycle is changed from 0% to 100%.
- Change the PWM signal frequency over the frequency range of 20Hz to (say) 20kHz and comment on your observation.
- We see the light intensity varied because the brightness is the result of some lowpass filtering (smoothing) effect. However, we did not use a RC circuit. What is the lowpass filter of the system?

Task 10: CR circuit & DC blocking



- Apply to this circuit a clock signal at 500Hz. Measure Vout using the scope and comment on the results.
- Not that the wave form you measure is identical no matter whether you set the scope to DC or AC mode. Why? (The sliding switch to select scope measure mode is on the top of the instrument.)
- Change the frequency to 30kHz. Observe and comment on the results.