ME 133 Winter 2023
Lab 3: *Plotter and Diodes*
February 2, 2023
Due: 2/10/2023

Submit a `zip` file named `yourFirstName-Lab1.zip` on Canvas with your code, a lab report (following the format in syllabus), and a short video proving the working hardware-software integration.

Exercise 1

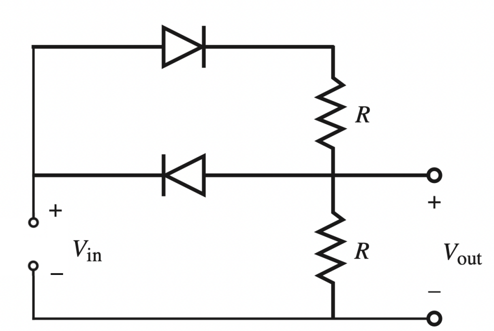
Material required

- Arduino
- Resistors
- 2 x Diodes

Coding together

You already know all it takes to code this problem. We will only look at the Serial Plotter, which is very similar to the Serial Monitor and allows to plot the value of a variable over time. Copy and paste into Matlab and plot the results.

Assignment

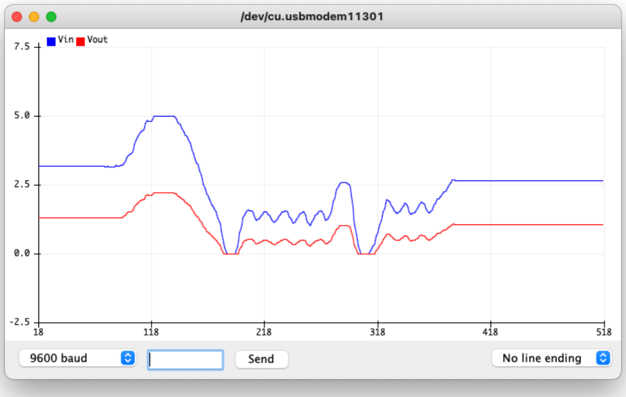


1. **Study** the circuit in the figure above. For a given $V_{in} > 0$, what is the value of V_{out}? Use either 2 or 1 K Ohm resistors (depending on the ones you received). Attach your calculations to the Report.
2. **Implement** the circuit with a tunable V_{in} and measure both V_{in} and V_{out} with your Arduino. Show both variables on the Serial Plotter (something like in the figure below, notice that the scale on the left is in Volt). Using a potentiometer is the recommended way to create the tunable power supply.
3. **Discuss** your result and whether the hardware implementation confirmed your math.

Exercise 2

Material required

- Arduino
- 1 x Transistor (PN 2222a)

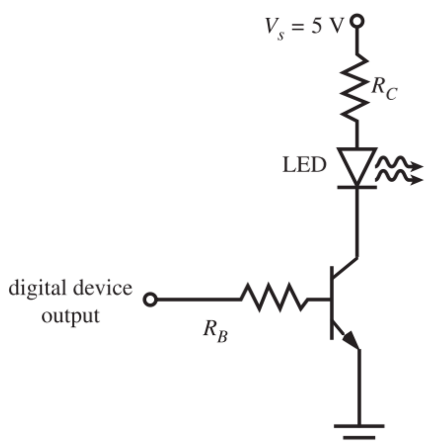


- 1 x 330 Ohm resistor
- 1 x 10 K Ohm resistor

Coding together

You will fly solo on this one.

Assignment



Consider the circuit in the figure above. Use the two data sheets (attached) to determine the appropriate values for the resistors R_c and R_b. You should ensure that the current through the LED is limited to within the max range and the transistor is in the saturation region when turned ON. What happens when the Arduino is set to HIGH (digital device output)? What about when its set to LOW? How much current is flowing trough the LED in each of the two cases? Motivate your conclusions.

Then, implement the circuit and have the Arduino set the pin connected to it as HIGH and LOW, alternatively. Discuss what happens and whether it matches with what you computed.

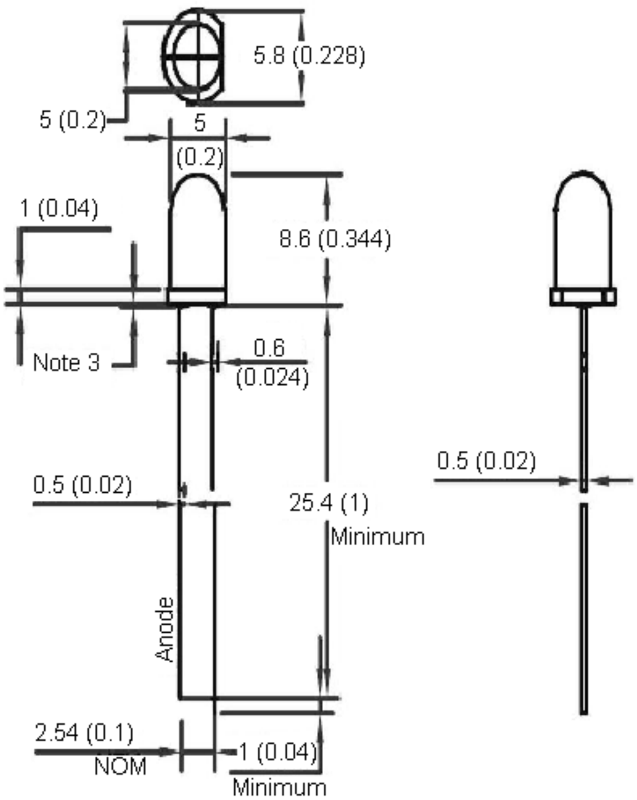
Standard LED

Red Emitting Colour

Features:

- High intensity
- Standard T-1 3/4 diameter package
- General purpose leads
- Reliable and rugged

Package Dimensions:



Dimensions : Millimetres (Inches)

Specification Table

Chip Material	Lens Colour	Source Colour	Part Number
AlGaAs	Diffused	Red	MV5754A

Notes:

1. Tolerance is ±0.25 mm (0.01”) unless otherwise noted
2. Protruded resin under flange is 1 mm (0.04”) maximum
3. Lead spacing is measured where the leads emerge from the package

Standard LED

Red Emitting Colour

Absolute Maximum Ratings at T_a = 25°C

Parameter	Maximum	Unit
Power Dissipation	80	mW
Peak Forward Current (1/10 Duty Cycle, 0.1 ms Pulse Width)	100	mA
Continuous Forward Current	20	
Derating Linear From 50°C	0.4	mA / °C
Reverse Voltage	5	V
Operating Temperature Range	-25°C to +80°C	
Storage Temperature Range	-40°C to +100°C	
Lead Soldering Temperature (4 mm (0.157) Inches from Body)	260°C for 5 s	

Electrical Optical Characteristics at T_a = 25°C

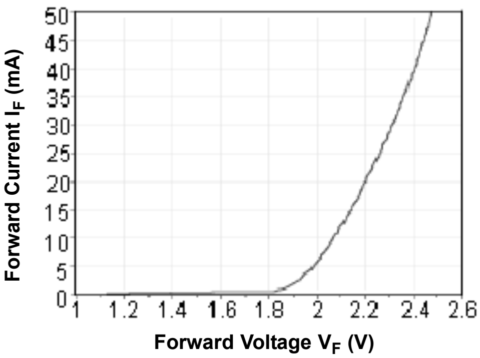
Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Condition
Luminous Intensity	I_v		40		mcd	I_f = 20 mA (Note 1)
Viewing Angle	$2\theta_{1/2}$		25		Deg	(Note 2)
Peak Emission Wavelength	λp		640		nm	I_f = 20 mA
Dominant Wavelength	λd		635		nm	I_f = 20 mA (Note 3)
Spectral Line Half-Width	$\Delta\lambda$		25		nm	I_f = 20 mA
Forward Voltage	V_f		2	2.5	V	I_f = 20 mA
Reverse Current	I_R	-	-	100	μA	V_R = 5 V

Notes:

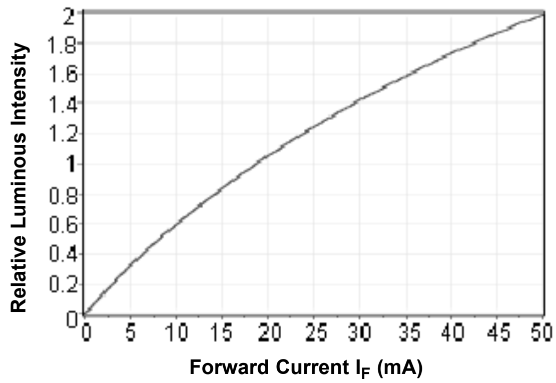
1. Luminous intensity is measured with a light sensor and filter combination that approximates the CIE eye-response curve
2. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity
3. The dominant wavelength (λd) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the colour of the device

Typical Characteristics

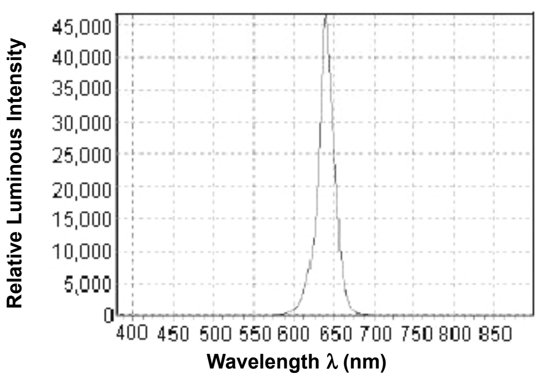
I_F - V_F (T_a = 25°C)



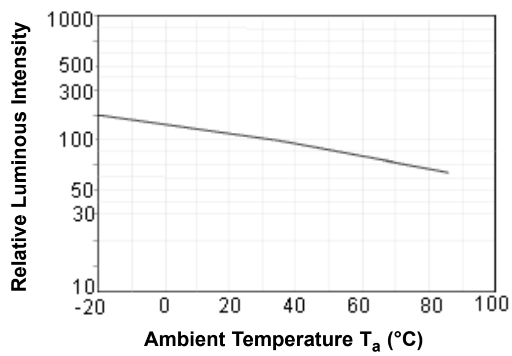
Relative Luminous Intensity - I_F (T_a = 25°C)



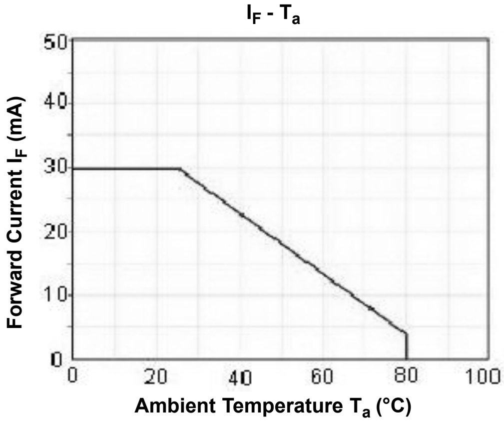
Wavelength Characteristics (T_a = 25°C)



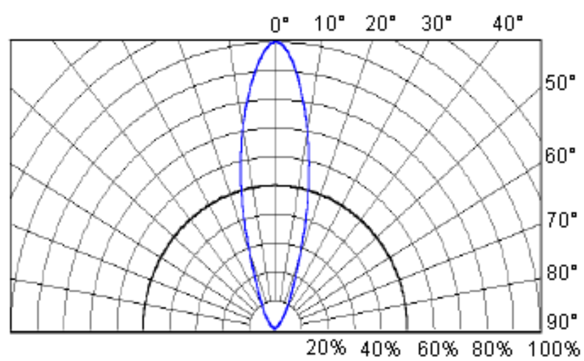
Relative Luminous Intensity - T_a



I_F - T_a



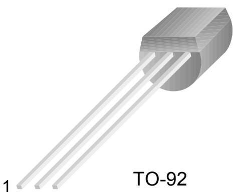
Directive Characteristics (T_a = 25°C)



FAIRCHILD SEMICONDUCTOR®

PN2222

General Purpose Transistor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TO-92

1. Emitter 2. Base 3. Collector

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	60	V
V_{CEO}	Collector-Emitter Voltage	30	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current	600	mA
P_C	Collector Power Dissipation	625	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-55 ~ 150	°C

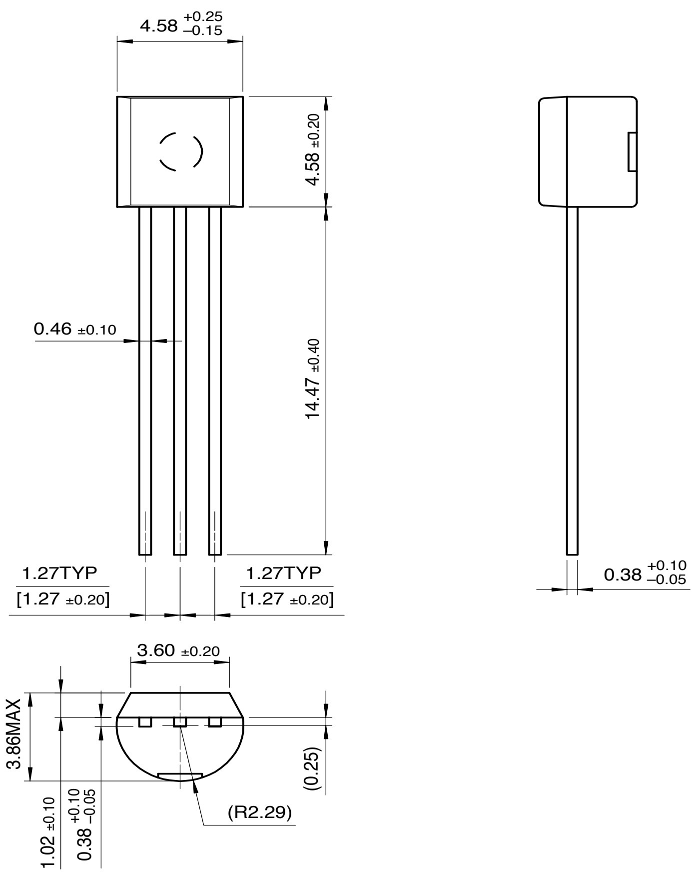
Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
BV_{CBO}	Collector-Base Breakdown Voltage	I_C=10μA, I_E=0	60		V
BV_{CEO}	Collector Emitter Breakdown Voltage	I_C=10mA, I_B=0	30		V
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E=10μA, I_C=0	5		V
I_{CBO}	Collector Cut-off Current	V_{CB}=50V, I_E=0		0.01	μA
I_{EBO}	Emitter Cut-off Current	V_{EB}=3V, I_C=0		10	nA
h_{FE}	DC Current Gain	V_{CE}=10V, I_C=0.1mA V_{CE}=10V, *I_C=150mA	35 100	 300	
V_{CE} (sat)	* Collector-Emitter Saturation Voltage	I_C=500mA, I_B=50mA		1	V
V_{BE} (sat)	* Base-Emitter Saturation Voltage	I_C=500mA, I_B=50mA		2	V
f_T	Current Gain Bandwidth Product	V_{CE}=20V, I_C=20mA, f=100MHz	300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		8	pF

* Pulse Test: Pulse Width≤300μs, Duty Cycle≤2%

Package Dimensions

TO-92



Dimensions in Millimeters

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CROSSVOLT™	GlobalOptoisolator™	MicroPak™	QFET®	SuperSOT™-8
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