Lab 21&22

- **Sepideh Mohammadi**

ECEN 5730
PCB DESIGN

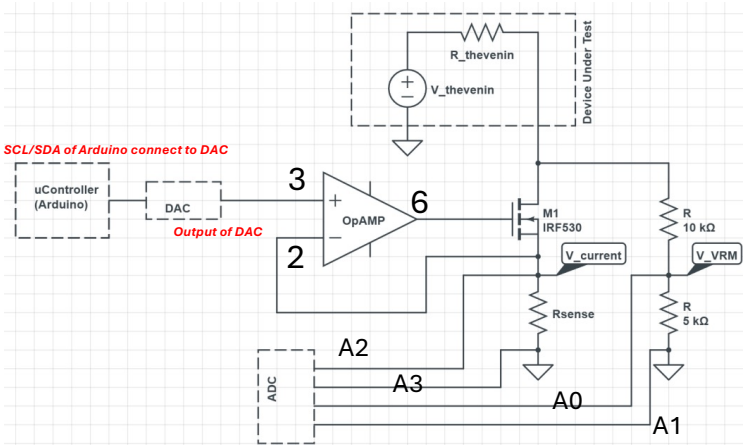
VRM Characterizer (Instrument Droid)

Overview Of the Circuit and Goal:

1. Objectives

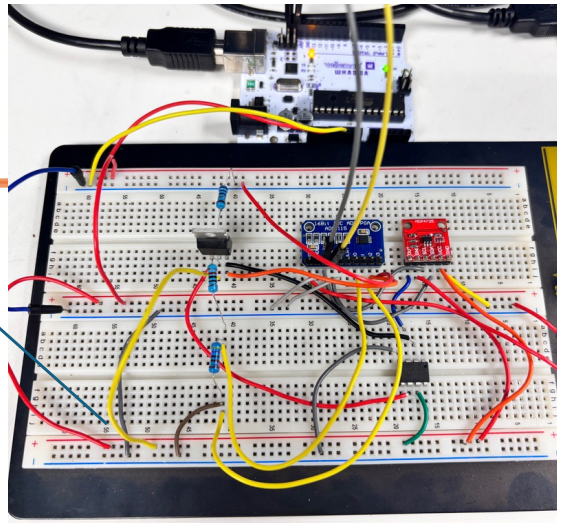
- To design and build a **breadboard version** of the VRM Characterizer (Board 4 SBB).
- To **measure the Thevenin voltage** and **Thevenin resistance** of a Voltage Regulator Module (VRM).
- To evaluate how **VRM output voltage drops** with increasing load current.
- To develop simple Arduino code to **sweep current**, take measurements, and compute **Thevenin equivalent** parameters.

Item	Qty
Arduino Uno/Nano	1
MCP4725(DAC)	1
ADS1115(ADC)	1
MCP601(op-amp)	1
TIP401(Mosfet)	1
Sense resistor(10Ω)	1
10 kΩ + 5 kΩ(voltage divider)	2



Overview of circuit after placing the components

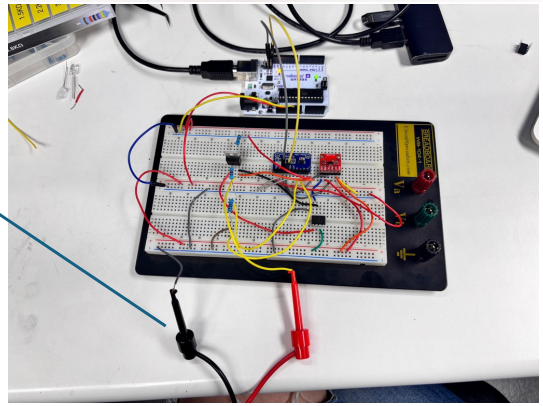
connect to 5vdc of Arduino



2. Goal

- Build a system that:
  - Applies a controlled current to a VRM.
  - Measures VRM voltage under **no-load** and **loaded** conditions.
  - Computes **Thevenin voltage (V_th)** and **Thevenin resistance (R_th)** using:
- $R_{th} = \frac{V_{open-circuit} - V_{loaded}}{I_{load}}$
- Demonstrate that the instrument can measure VRM performance across a range of currents.

Function generator



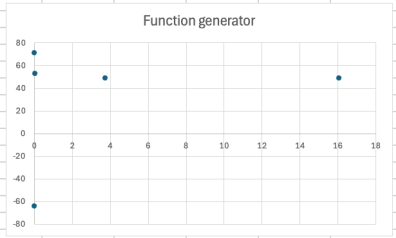
EXPERIMENTAL SETTUP

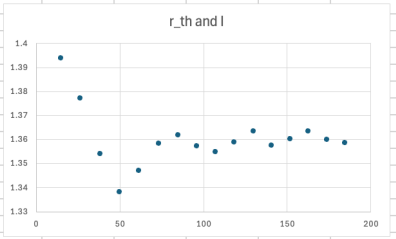
1. Function Generator Results (Top Table)
Current range: 0.002 mA → 16.05 mA
R_th range: –64 Ω → +71 Ω → +48 Ω

What it shows:
At extremely **low currents**, the measured values fluctuate wildly (negative and positive).
As current increases above **~3 mA**, the R_th values stabilize around **48–52 Ω**, which is consistent with a typical Thevenin resistance of the function generator output.

function generator				
A	B	C	D	E
Index	current_mA	V_thevenin	V_loaded	R_thevenin
1	0.002	2.629	2.6291	-64.2596
2	0.002	2.629	2.6288	71.1872
3	0.026	2.6289	2.6276	52.6364
4	3.746	2.6289	2.4452	49.0304
20	16.053	2.6289	1.8441	48.8903

Arduino				
F	G	H	I	
Index	current_mA	V_thevenin	V_loaded	R_thevenin
5	14.501	4.6668	4.6466	1.394
6	26.286	4.6668	4.6306	1.3772
7	38.077	4.6668	4.6153	1.3542
8	49.819	4.6668	4.6001	1.3383
9	61.448	4.6667	4.5839	1.347
10	73.094	4.6666	4.5673	1.3585
11	84.597	4.6667	4.5514	1.3619
12	95.989	4.6667	4.5364	1.3574
13	107.153	4.6668	4.5216	1.355
14	118.345	4.6667	4.5059	1.3589
15	129.657	4.6667	4.4899	1.3634
16	140.709	4.6667	4.4756	1.3576
17	151.64	4.6667	4.4605	1.3602
18	162.636	4.6667	4.4449	1.3635
19	173.485	4.6666	4.4307	1.3599
20	184.383	4.6667	4.4162	1.3587





2. Arduino VRM Results (Bottom Table)
Current range: 14 mA → 184 mA
R_th range: 1.347 Ω → 1.394 Ω
What the plot shows:
The R_th values stay **very consistent**, between **1.34 Ω and 1.39 Ω**.
As current increases, R_th **slightly decreases**, then slowly increases again, but only by about **0.03–0.04 Ω**.
The plot is basically **flat**, showing very little change in Thevenin resistance with load.

Summary

- The Thevenin resistance of the Arduino VRM is low (~1.36 Ω) and remains very stable as the load current increases. The function generator exhibits much higher Thevenin resistance (~50 Ω) and shows large measurement error at very low currents. Overall, the Arduino VRM demonstrates strong load regulation, while the function generator behaves as a weaker source with significantly higher internal resistance.