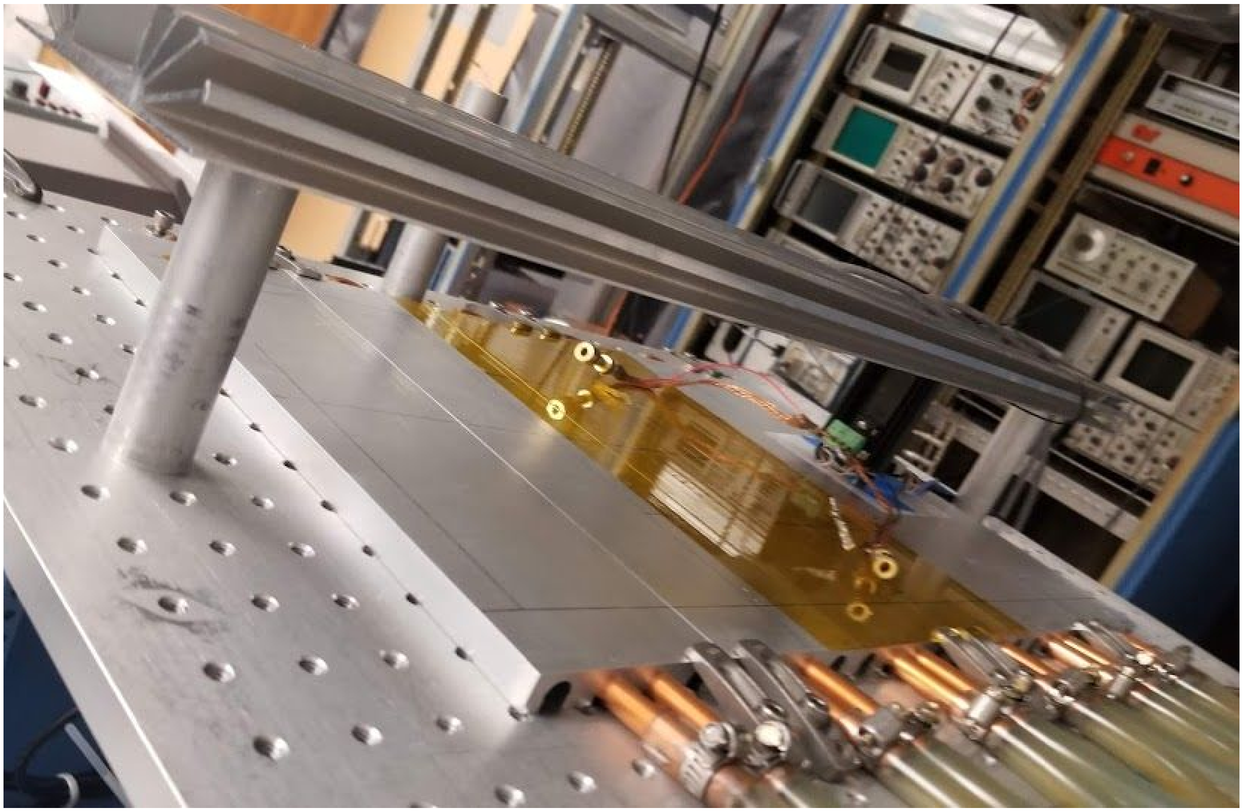

PV Curve Tracer Design Document

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Team

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Overview

This proposal outlines the goals, major design decisions, and processes to develop a photovoltaic curve tracer for cell, module, and solar array testing for the UT Solar Vehicles Team.

Goals

1. Update the current EER setup with a flexible, rugged, and versatile setup.
2. Design a testing setup that is able to test cells, modules, and subarrays, both indoors and outdoors, and provide data that is easily exportable and usable.

Specifications and Milestones

Specifications

There is no current allotted budget for this project.

The design should allow solar array teams to test multiple hierarchies of PVs.

The design should be small and easy to move and setup for outdoor and indoor environments.

The design should collect and store data that can be easily analyzed by applications such as Microsoft Excel and Google Sheets.

Milestones

I. PV Curve Tracer Design is completed.

A base set of functionality is identified, and a preliminary and detailed design is presented. Candidate components are selected, a PCB schematic is created, and the design passes verification.

II. PV Curve Tracer Software is defined and written.

Using a base from BPS or created from scratch, software is written to do the following:

1. Set program configuration (i.e., populating a file with headers for a cell compared to a module level test).
2. Guide the user (i.e. Telling the user to twist the rotary switch to a specific position, attach the PV leads, etc).
3. Run a scan and collect the results.
4. Error handle or raise concerns if incongruent data is received.
5. (**EXTENSION**) Run a continuous mode that shows multiple scans and identifies the best run. Useful for outside testing as conditions change over time.

III. PV Curve Tracer is assembled.

Parts for a prototype are ordered and received. The PCB is assembled and initial electrical tests pass. Additionally, the RTD board designed by Hannah from BPS is also assembled and electrically and software tested.

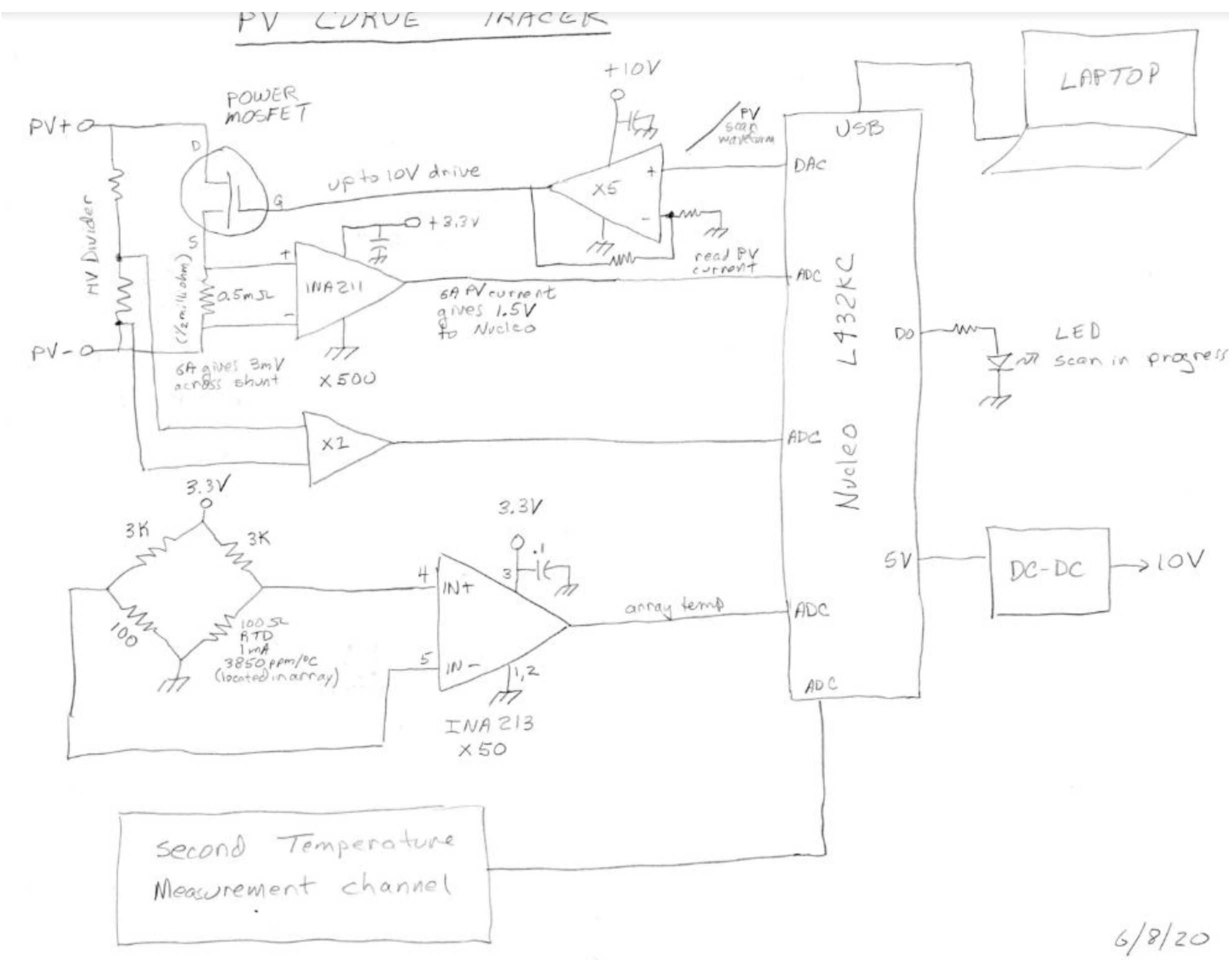
IV. PV Curve Tracer is tested and operational.

The prototype software is tested. Scans can be made for each PV type and the data output resembles useful data.

Electrical Design

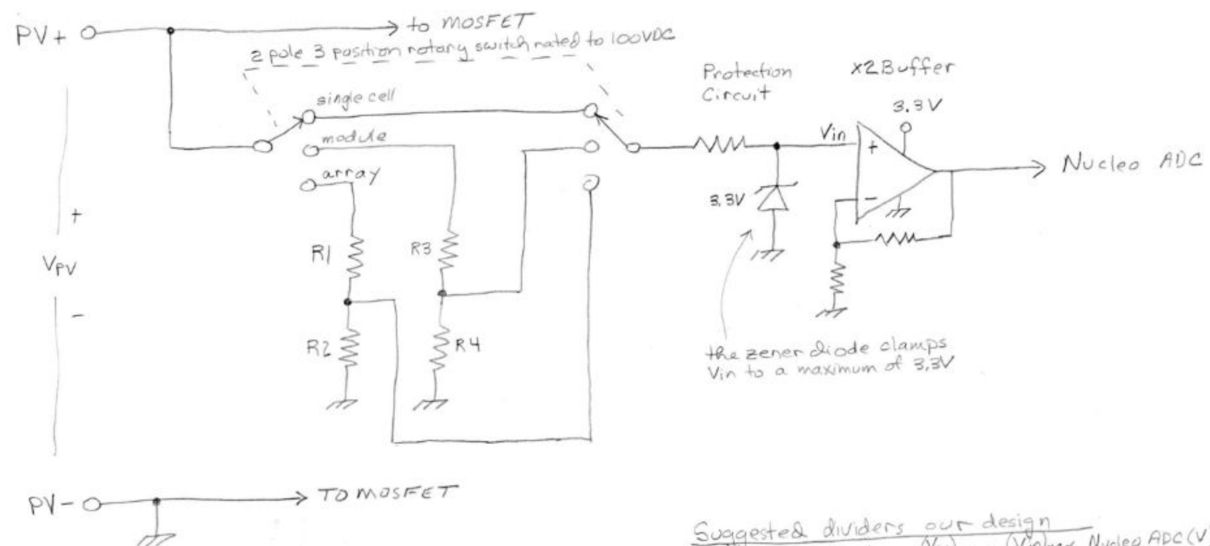
An initial idea we're taking inspiration from is the open source project IV SWINGER,

Professor Hallock has proposed the initial design below:



PV CURVE TRACER
POWER MOSFET
PV+
PV-
HV Divider
D
G
S
up to 10V drive
+10V
X5
PV scan waveform
DAC
USB
LAPTOP
+3.3V
INA211
0.5mΩ
(1/2 milliohm)
6A PV current gives 1.5V to Nucleo
read PV current
ADC
6A gives 3mV across shunt
X500
X1
Nucleo L432KC
D0
LED
scan in progress
3.3V
3K
3K
100
100Ω RTD 1mA 3850ppm/°C (located in array)
IN+
IN-
INA213
X50
array temp
5V
DC-DC
10V
Second Temperature Measurement channel
6/8/20

PV Curve Tracer – Voltage Measurement



Suggested dividers our design

mode	divider	$(V_{PV})_{max}$	$(V_{in})_{max}$	Nucleo ADC (V)
single cell	direct	.6	.6	1.2
module	R3/R4	10	1.5	3
array	R1/R2	90	1.5	3

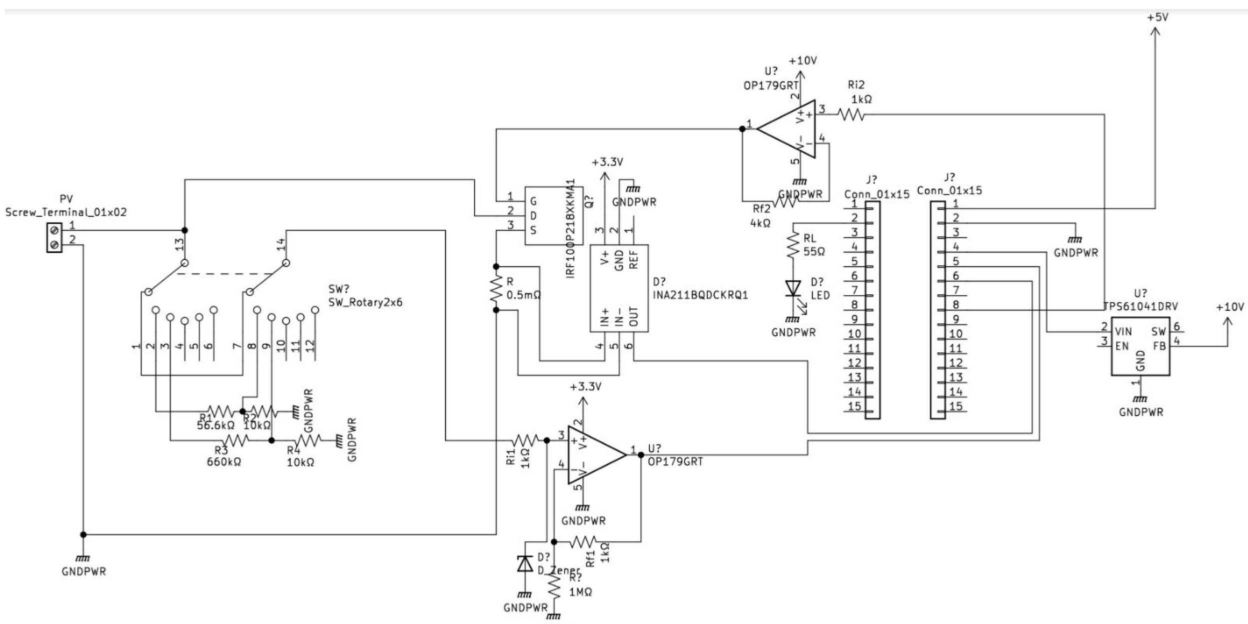
Voltage Divider

$$V_{in} = \left(\frac{R2}{R1+R2}\right)V_{PV}$$

Swinger 2 uses R2 = 7.5KΩ + R1 = 150KΩ

$$V_{in} = \left(\frac{7.5}{150+7.5}\right)V_{PV} = (.0476)V_{PV}$$

For 60V array voltage $V_{in} = (.0476)(60) = 2.86V$



Components:

- Nucleo L432KC
- X5 Amplifier, 10V input, up to 10V drive
- POWER MOSfet Infineon IRF100P218
- INA211 6A PV current gives 1.5V to nucleo
- X2 3.3V input, up to 3V drive
- DC-DC converter, 5V to 10V
- LED (green)
- CAN
    - ADM3055E
    - Capacitors
    - Resistors
    - Inductors
    - CDSOT23-T24CAN
- HV Divider
    - Rotary switch - 3 modes, break before make, dual rotary switch, good for 100V, 10A
    - Cell measurement - no resistance (0-.6V maps directly to ADC)
    - Module measurement (0-10V, consider a 7:3 top to bottom ratio, and perhaps resistances on the order of 10k)
        - 70k ohm and 30k ohm
        - 3V at output
    - Subarray measurement (0-100V, consider a 33:1 top to bottom ratio, and perhaps resistances on the order of 100k)
        - 330k ohm and 10k ohm
        - 3V at output
    - Protection circuitry - zener diode

Part Name	Cost	Function	Additional Notes
Nucleo L432KC 15 pin 2.54mm header	1.76 1.05	uC	We already have a couple of these.
X5 Amplifier Mouser	7.10		Unsure about these
X2 Amplifier			Unsure about these
Infineon IRF100P218	7.45	N-type Power MOSFET for voltage switching	Approved by Prof. Hallock
INA211	1.54	Current Op Amp	Gain of 500, V_S=2.7-26V V_{cm}=-.1-26V
DC-DC Converter	3.63	Input V+ x5 Op Amp	5V to +-10V, 10mA output, 8kHz switching
LED	.99	Various functions and indicators	2V, 30mA I_fwd, 5mm pitch
CAN			See Electronics Schematics for Hannah's RTD board
HV Divider			
No Cell			Nothing
Module (5.66:1) 56.6k Ohm Resistor 10k Ohm Resistor	56.6kOhm: .40 10kOhm: .51	Module level voltage divider	56.6kOhm, 1%, 1/8W, 50 PPM/C, 200V, .6x3.2mm 2W, 30kOhm, 3.9x9mm
Array (66:1) 660k Ohm Resistor 10k Ohm Resistor	660kOhm (2 330k): .48 10kOhm: .51	Array level voltage divider	330kOhm (x2), 1/4W (x2), 100 PPM/C, 800V, .6x3.2 (2) mm 2W, 350V, 10kOhm,

			5x15.5mm
1 SPDT switch Datasheet 2 DPDT switches Datasheet Screw Mounts	SPDT: 6.82 DPDT: 27.20 Screw Mounts: .58	Switching between PV modes	OFF-ON, throughhole mounting, 10A ON-ON, throughhole mounting, 20A, 250DC 5mm pitch, 15A 300V right angle screw mounts for 12-22 AWG
Zener diode	.16	Battery Protection	3.3V, 10mA zener current, 25uA reverse current, 28Ohm, 500mW, 2x4.2mm Is this the specs we want?
Screw Terminal Mounts	1.69	Connecting array leads	2x1, 16A, 500W, max 16AWG Through hole, 14.5x12mm

Software Design