



DesignNews

Exploring Electronic Circuits with Breadboards, AI Circuit Analysis, and Simulators

DAY 1 : Electronic Circuit Schematic Diagrams and Solderless Breadboards – New Perspective

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Dr. Don Wilcher

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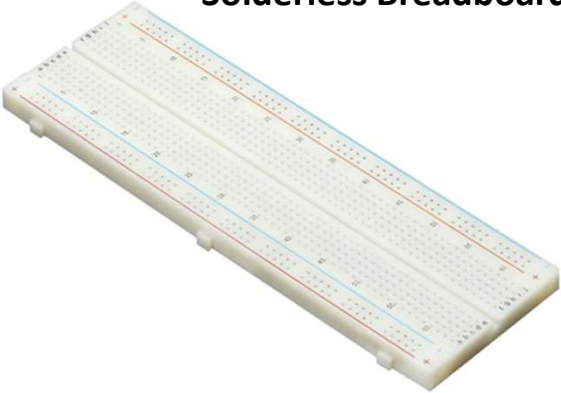
Course Kit and Materials



Adafruit Parts Pal Kit



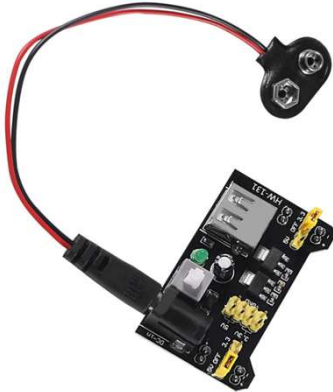
Solderless Breadboard



Jumper Wires: Male to Male



Solderless Breadboard Power Supply



Research Perspective

“Breadboards are widely used in early-stage circuit prototyping since they enable users to rapidly try out different components and to change the connections between them” (Zhu et al., 2020).

Agenda:

- The Solderless Breadboard Evolution
- The Solderless Breadboard Market
- The Solderless Breadboarding-New Perspectives
- How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?
- Lab: Build a Light Sensor with a 7 Segment LED Display

The Solderless Breadboard Evolution



- The Solderless Breadboard provides a foundational platform for:
 - a) developing electronic circuit designs.
 - b) testing electronic circuit designs.
- The main goal is to rapidly prototype an electronic circuit design without soldering components.
- The solderless breadboard construction consists of:
 - a) plastic board with grid holes or cavities.
 - b) grid holes or cavities are embedded within the plastic board.
- Before the solderless breadboard, electrical or electronic circuits were built using:
 - a) an actual breadboard.
 - b) wood nails or Fahnestock clips to wire electrical and electronic components together.

The Solderless Breadboard Evolution

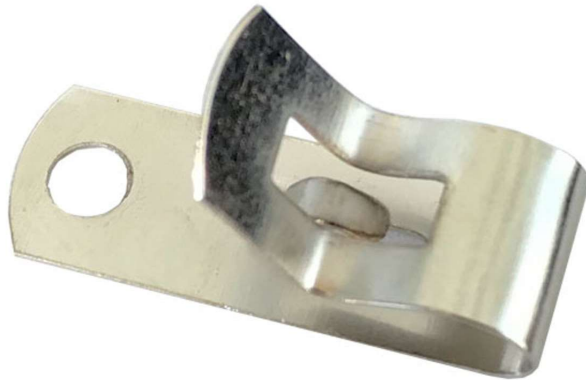


Image: Science Kit Store



Image: Wikipedia

Question 1

Before the solderless breadboard, electrical or electronic circuits were built using a simulated breadboard.

- a) True**
- b) False**



The Solderless Breadboard Evolution...

Circuit Building using Wooden Breadboards

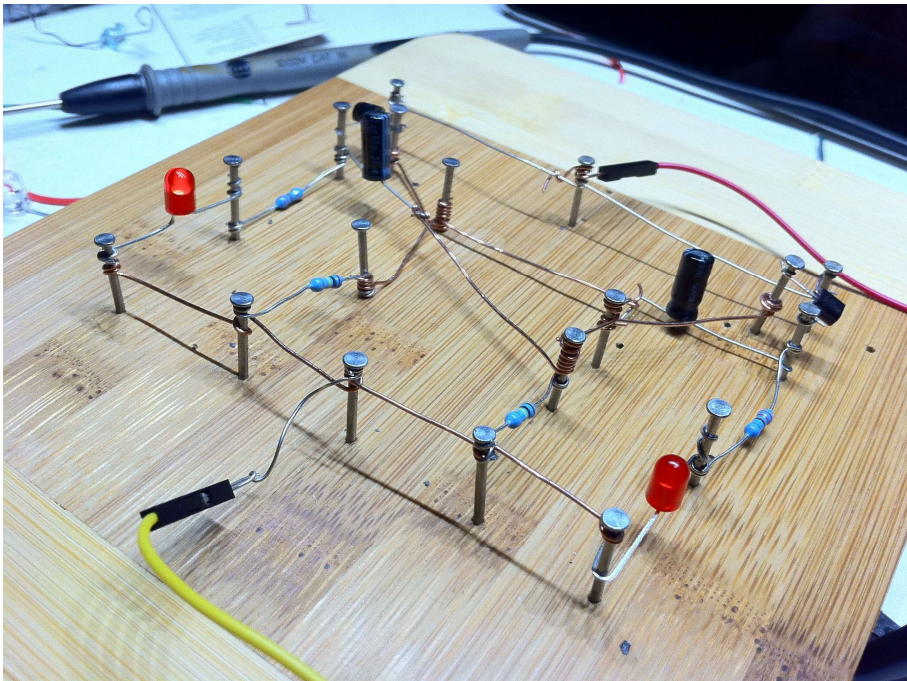


Image: Adafruit Industries



Image: Sparkfun Electronics

The Solderless Breadboard Evolution...



April 9, 1963

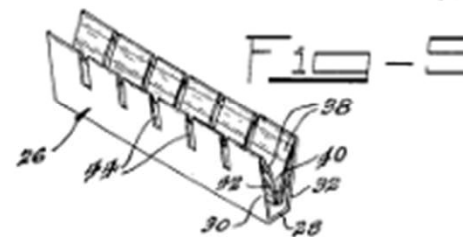
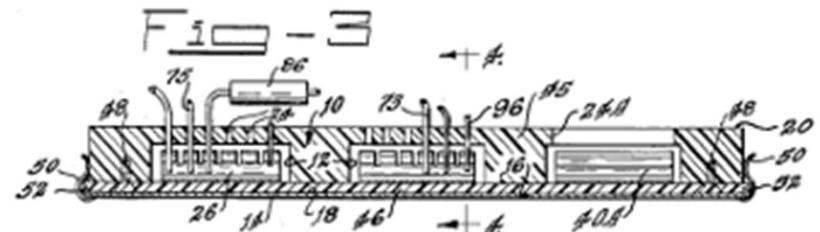
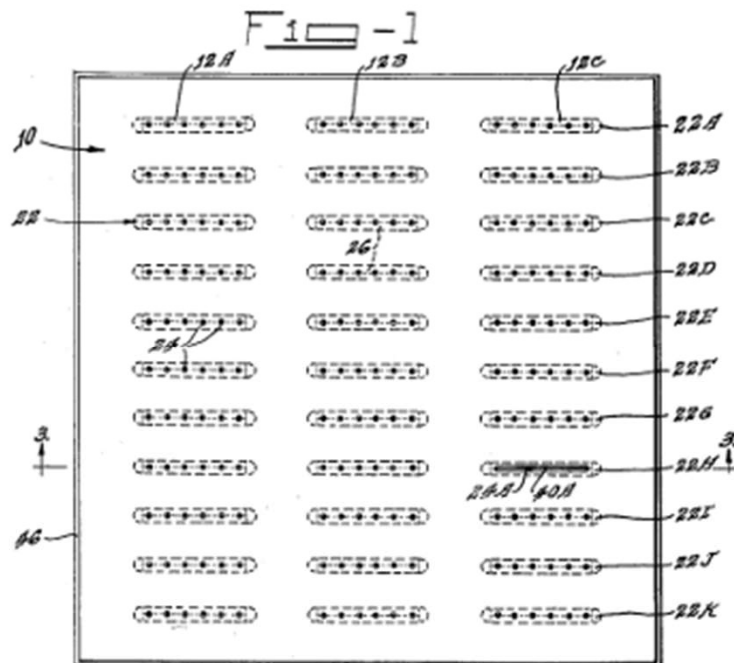
O. I. THOMPSON
DEVICE FOR FACILITATING CONSTRUCTION
OF ELECTRICAL APPARATUS

3,085,177

Filed July 7, 1960

2 Sheets-Sheet 1

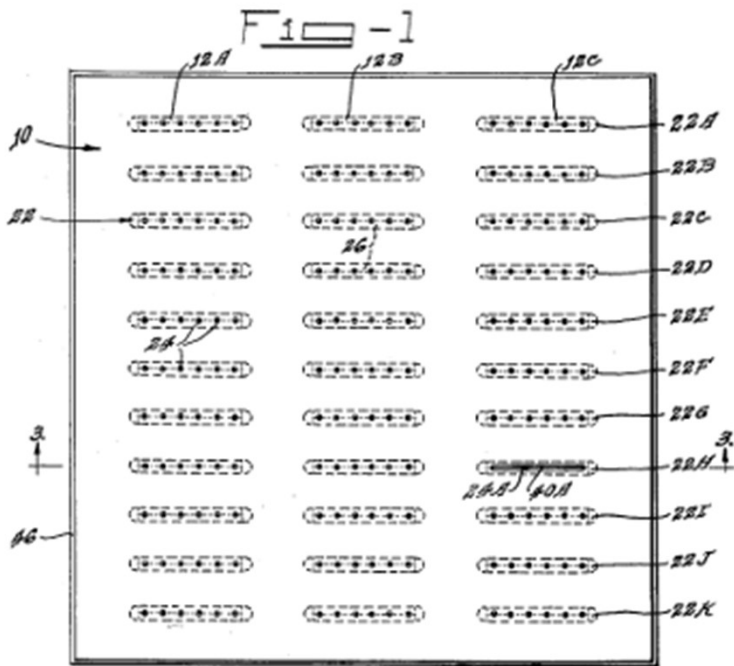
First Solderless Breadboard Design



INVENTOR
Orville I. Thompson
BY *Stone, Nierman,
Burmeister & Zimmer
Attorneys*

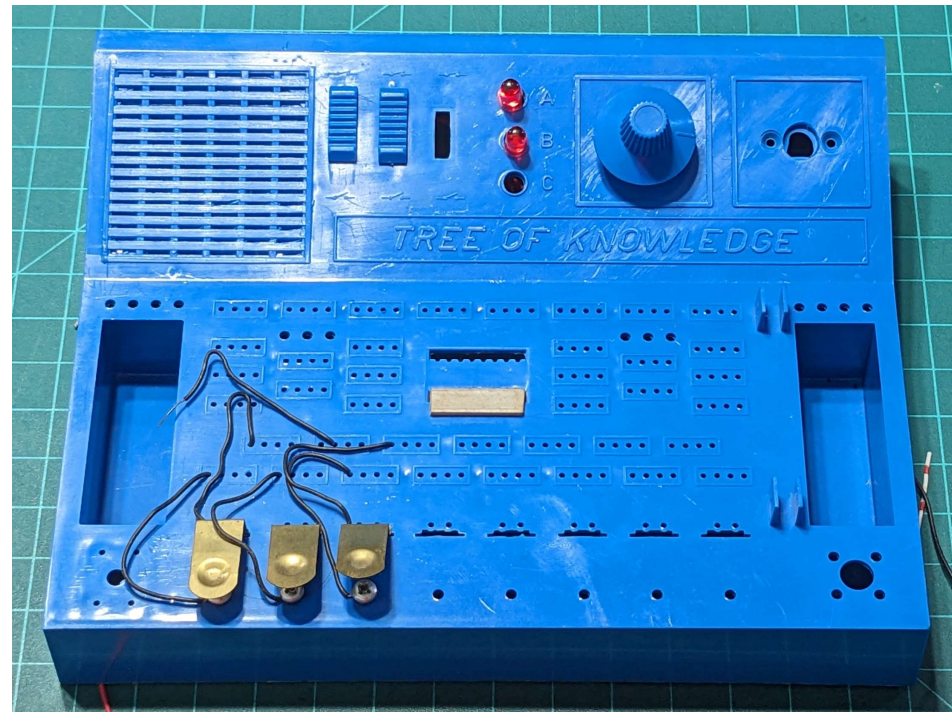
Images: US Patent Office

The Solderless Breadboard Evolution...

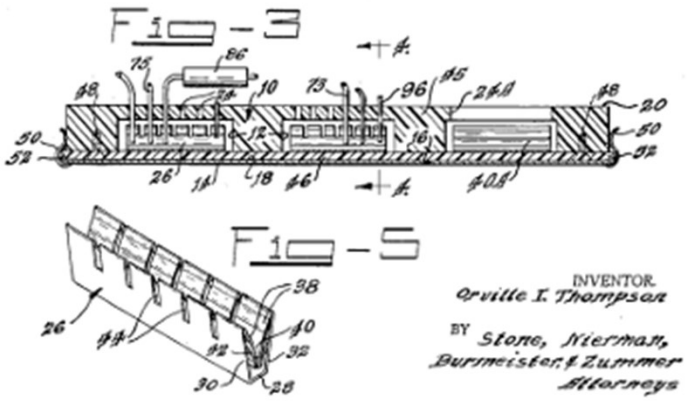
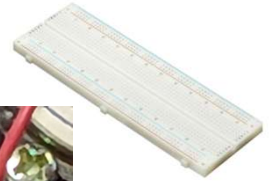


Example Solderless Breadboard Product

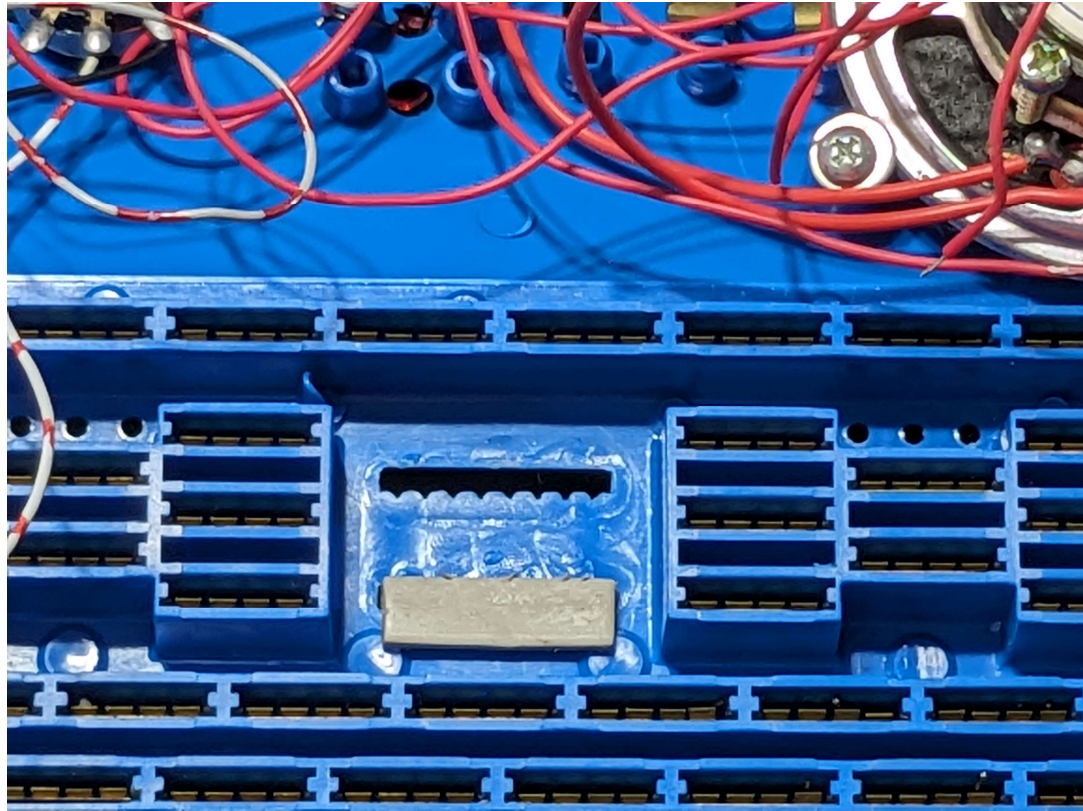
Example Solderless Breadboard Product



The Solderless Breadboard Evolution...



Bottom Construction



The Solderless Breadboard Evolution...

228,136

**BREADBOARD FOR ELECTRONIC COMPONENTS
OR THE LIKE**

Ronald J. Portugal, North Haven, Conn., assignor to
EI Instruments Incorporated, Derby, Conn.

Filed Dec. 1, 1971, Ser. No. 203,938

Term of patent 14 years

Int. Cl. D13—03

U.S. Cl. D26—1 R



FIG. 1

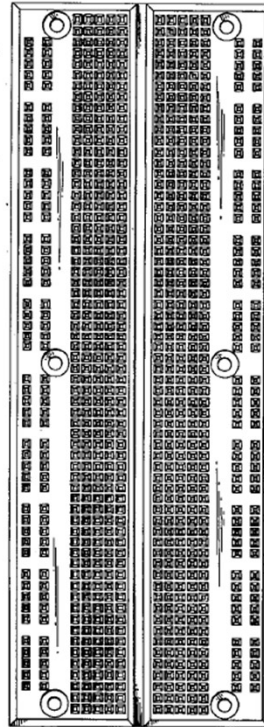


FIG. 2



FIG. 3

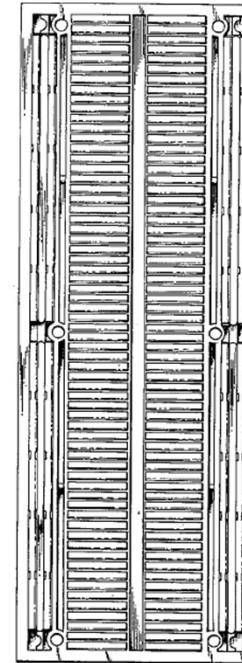


FIG. 4



Final Solderless Breadboard Design

Question 2

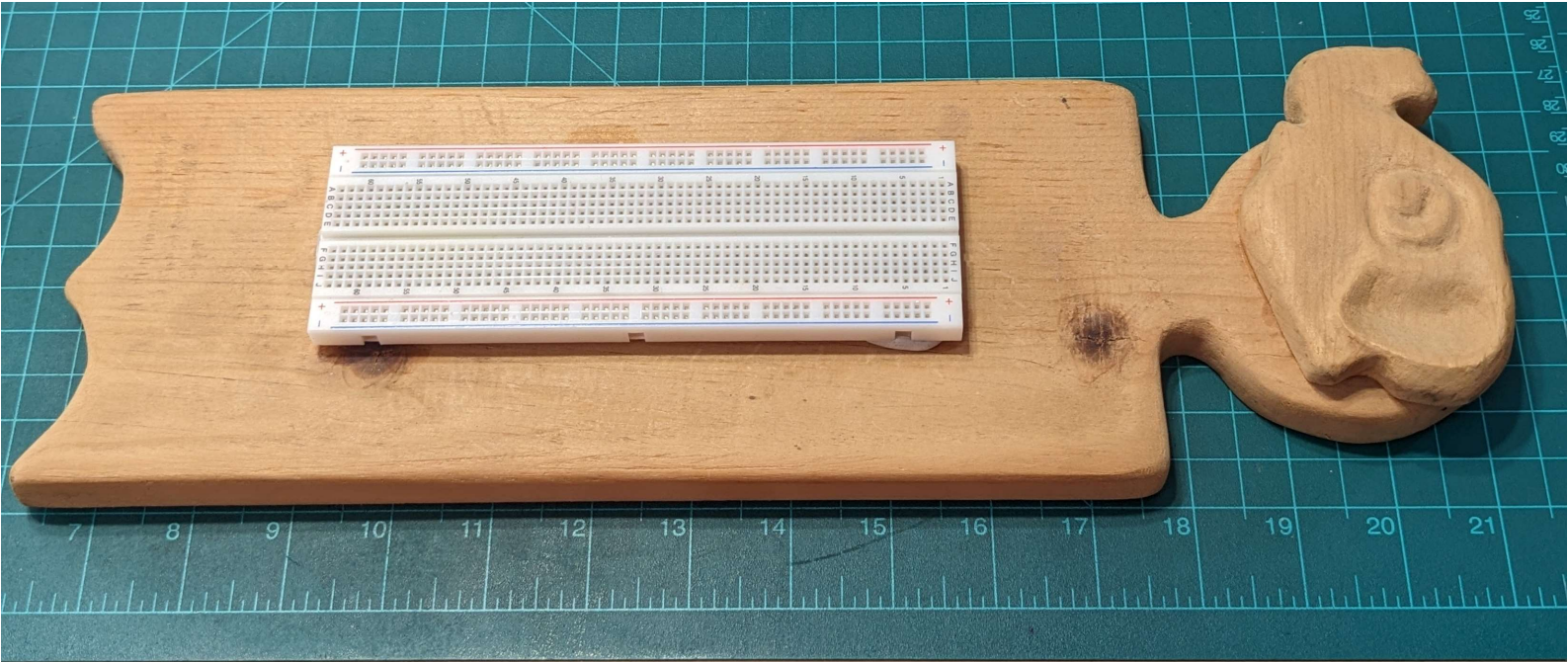
Who was the inventor that received a patent on April 9, 1963, for the Device For Facilitating Construction of Electrical Apparatus?

- a) Ronald J. Portugal**
- b) Rufus P. Turner**
- c) O.L. Thomas**
- d) Forrest M. Mims**



The Solderless Breadboard Evolution...

Mashup Solderless Breadboard Design



The Solderless Breadboard Market

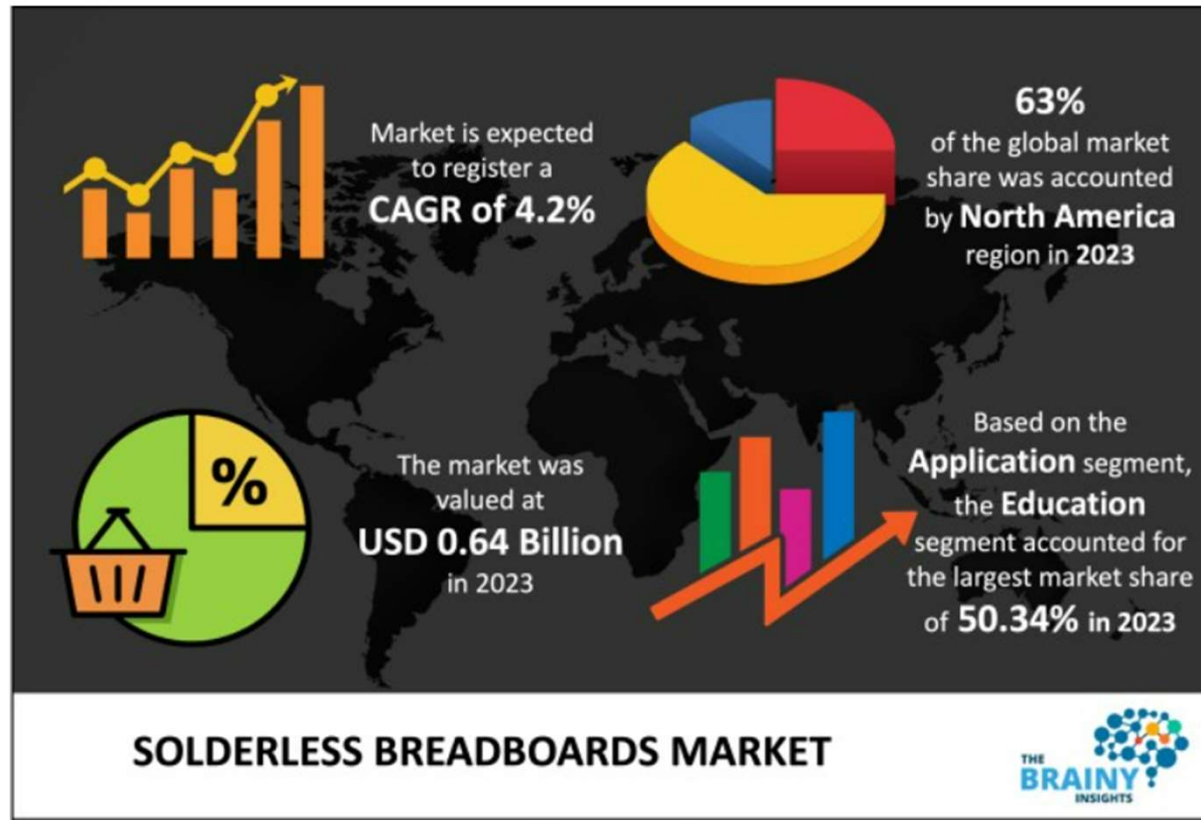


- The Brainy Insights (2024, May) reported the global Solderless Breadboard market was valued at 0.64 billion USD.
- The solderless breadboard market is expected to reach 0.97 billion USD by 2023.
- The Compound Annual Growth Rate (CARG) is 4.2% from 2024 to 2033.
- The potential drive behind the market is based on the following elements.
 - a) DIY Projects growing demand
 - b) Educational programs (accounting for 50.34% of the growth rate)
 - c) Research and Development Initiatives
 - d) Technological advances in Online Sales for market expansion
 - i. Solderless breadboard technology has advanced to meet the changing demands of users.
 - ii. Developments in connectivity options, upgrades in power distribution mechanisms, and contact reliability impact solderless breadboard versatility and usage.

The Solderless Breadboard Market...



Solderless Breadboard Market Infographic



Question 3

According to Brainy Insights (2024, May), the Solderless Breadboard Market should have a Compound Annual Growth Rate (CARG) of 5.2% from 2024 to 2033.

- a) False**
- b) True**



The Solderless Breadboard –New Perspectives...



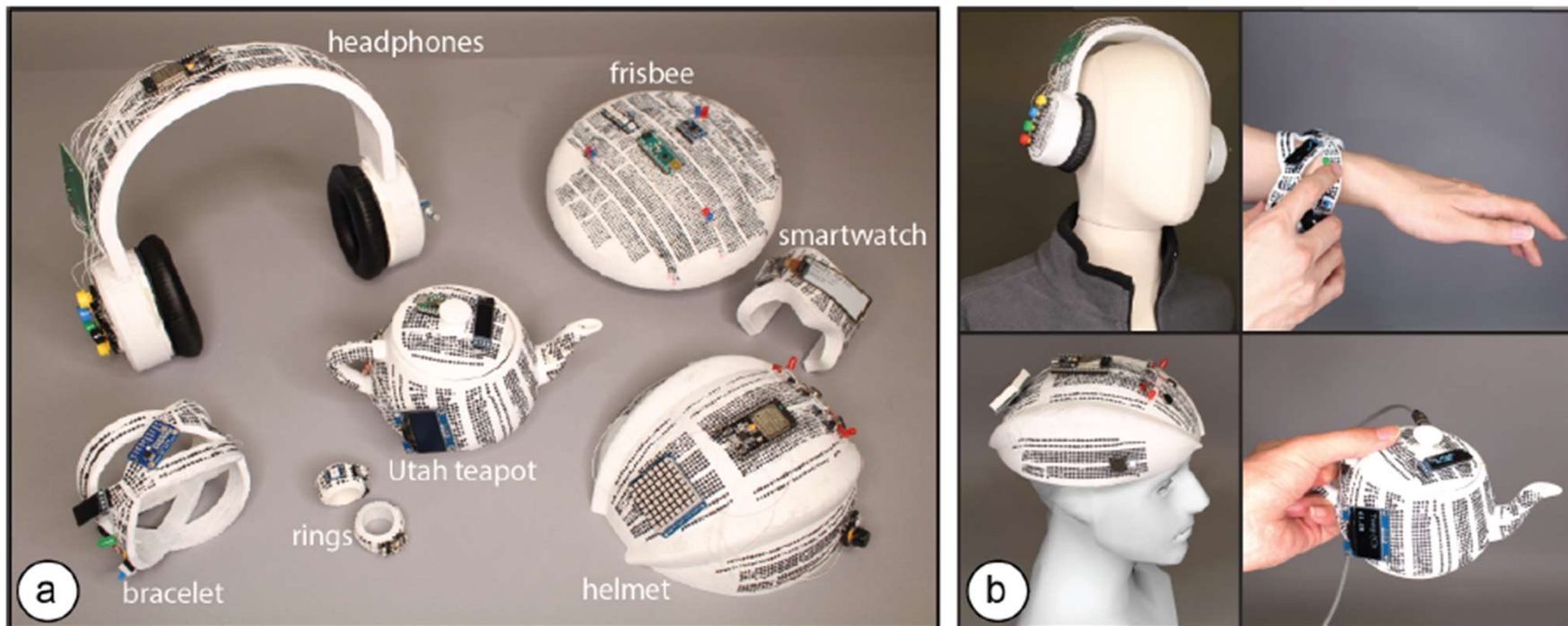
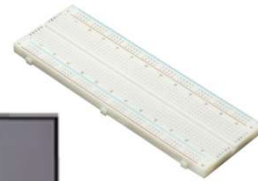
- Integrating breadboards into physical objects (Zhu et al., 2020) is being explored by HCI researchers.
 - b) promoting recycling and reuse of electronic thru-hole components.
- Design concepts for recycling and reuse of SMD components consist of:
 - a) using small Printed Circuit Board (PCB) elements that allow attaching leads or female header pins for mounting into solderless breadboards.
 - b) printing 3D housing that can mechanically mount SMDs into custom PCBs with female header pins for mounting into solderless breadboards (Yan et al., 2024).
 - c) Human-Computer Interaction (HCI) research in effective circuit assembly and disassembly of SMD and thru-hole components for solderless breadboards.

The Solderless Breadboard –New Perspectives...



- The design goal of new solderless breadboard perspectives relates to:
 - a) reuse of surface mount devices (SMDs) components.
 - b) promoting recycling and reuse of electronic thru-hole components.
- Retro perspective solderless assembly (Fjelstad, n.d.) approaches for recycling and reuse of SMD components consist of:
 - a) twisted wire attachments.
 - b) wire wrapping.
 - c) press-fit pins.

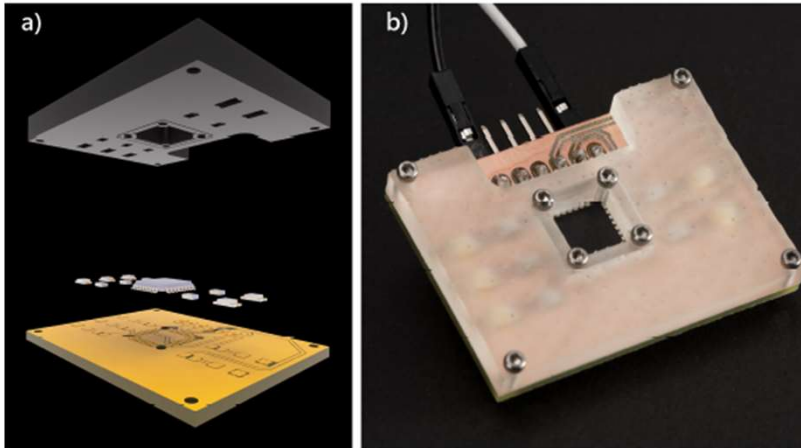
The Solderless Breadboard - New Perspectives...



CurveBoards Images: Zhu et al. (2020)

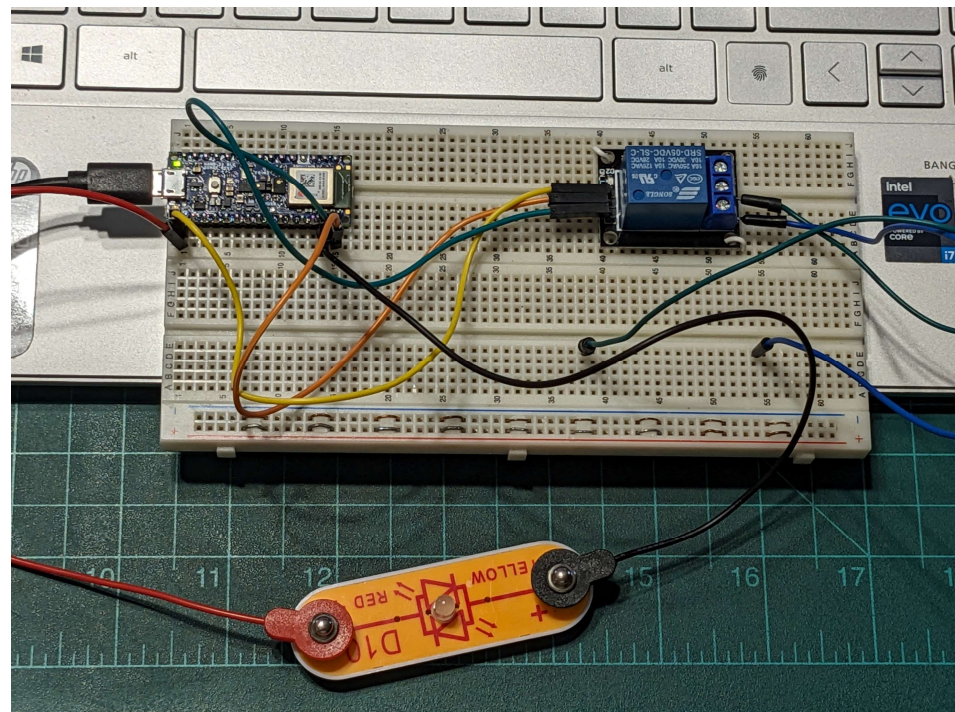
The Solderless Breadboard - New Perspectives...

SNAP Elements and Modular
Component PCBs

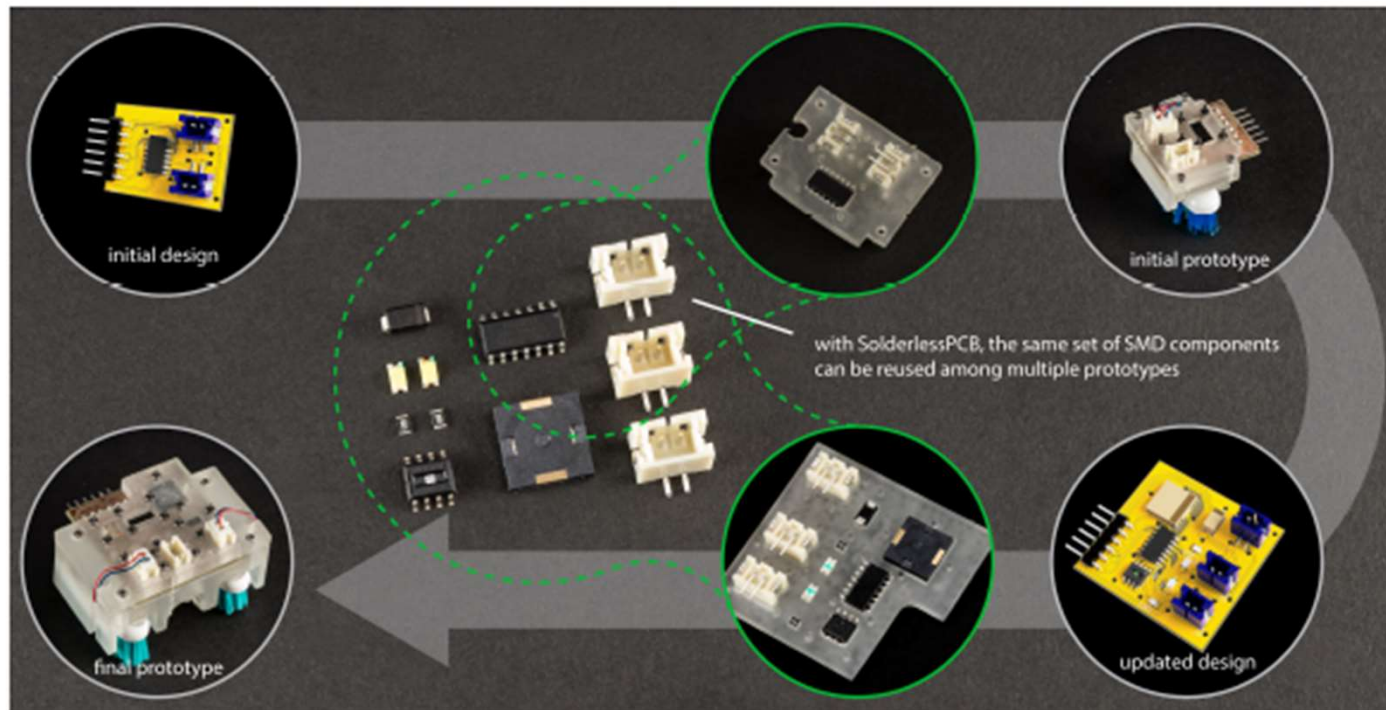


SolderlessPCB

Image: Yan et al. (2020)



The Solderless Breadboard -New Perspectives...



SolderlessPCB Image: Yan et al. (2020)

Question 4

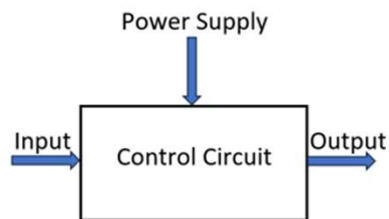
The design goal of new solderless breadboards relates to:

- a) reuse of SMD and electronic thru-hole components**
- b) reuse of SMD components and electromechanical parts**
- c) reuse of materials and SMD components**
- d) none of the above**

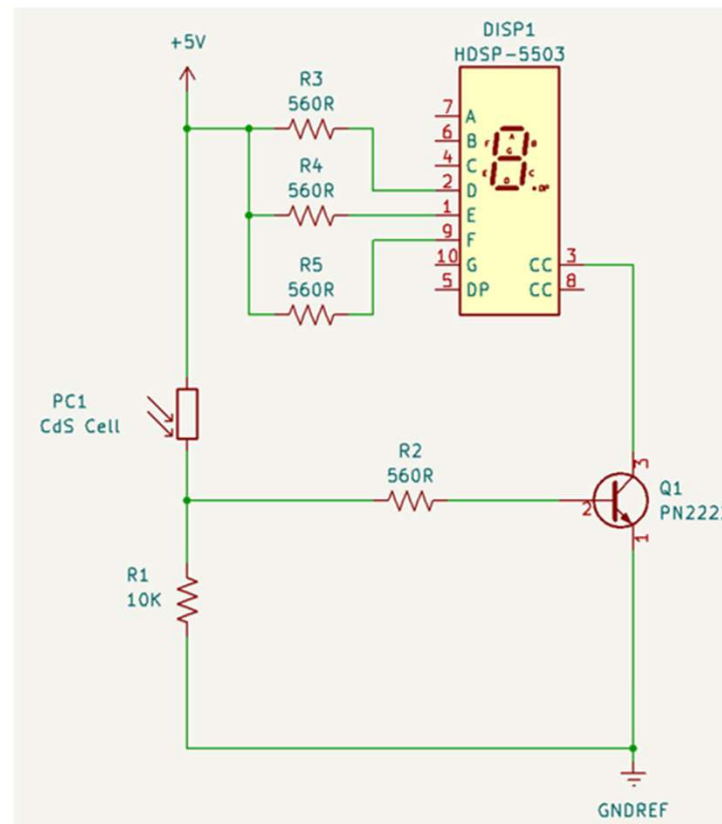
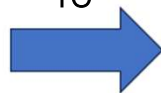


How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?

Block Diagram



To



Electronic
Circuit
Schematic
Diagram



How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?...



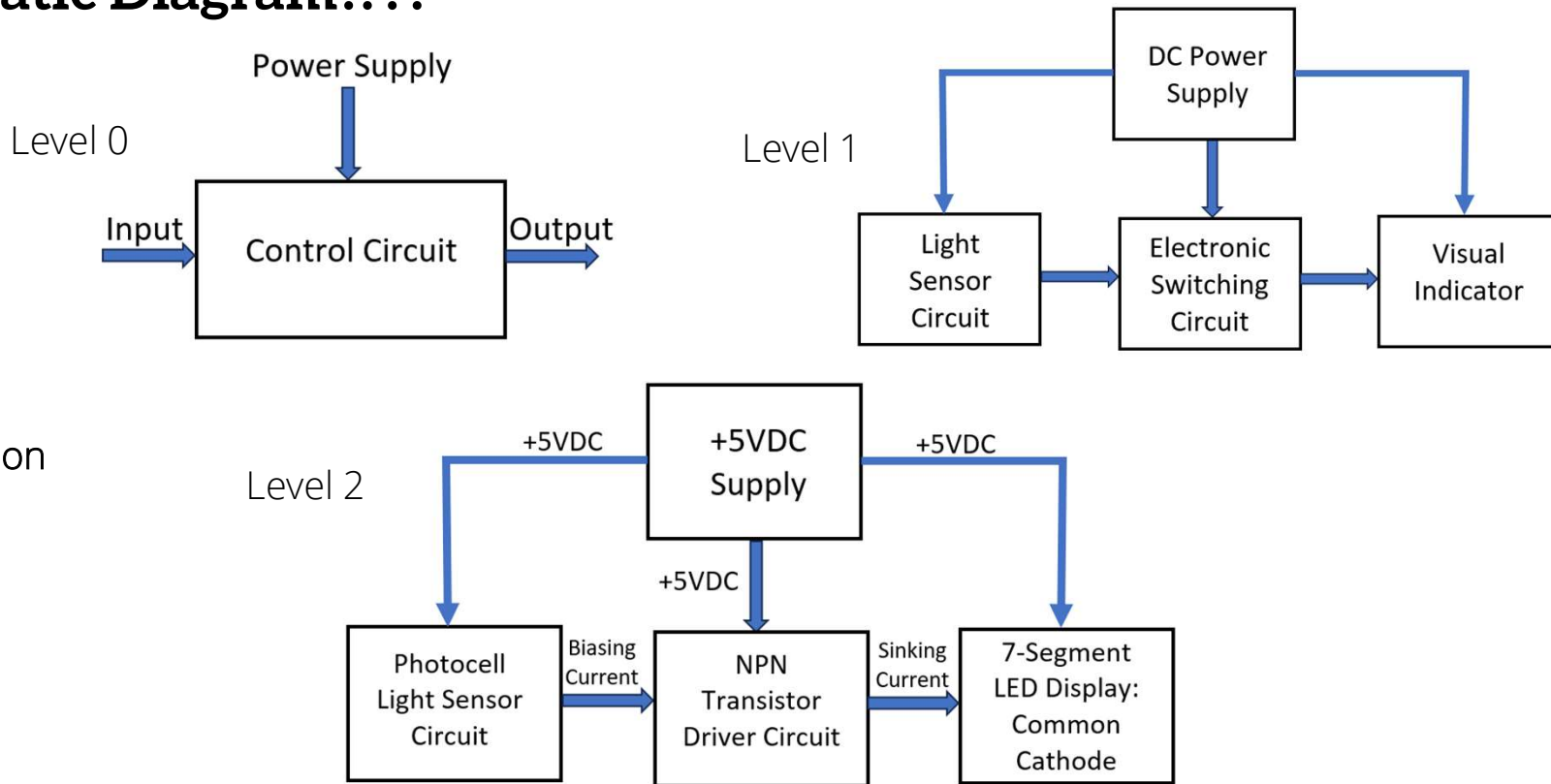
Steps to Creating an Electronic Circuit Schematic Diagram from a Block Diagram.

1. Draw 4 levels of Block Diagrams to capture the target circuit's functional architecture.
2. Draw an Electronic Circuit for each block created in the Level 2 block diagram.
3. Label each electronic part with a Reference Designator (REF DES), part name, or value.

How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?...



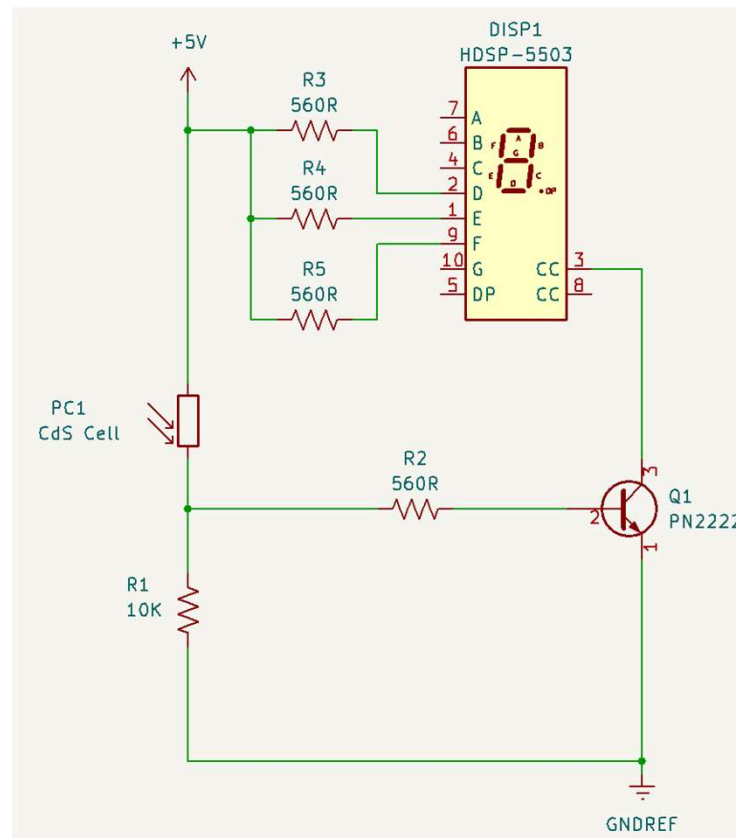
Step 1:
Functional
Decomposition



How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?...

Step 1:
Functional
Decomposition

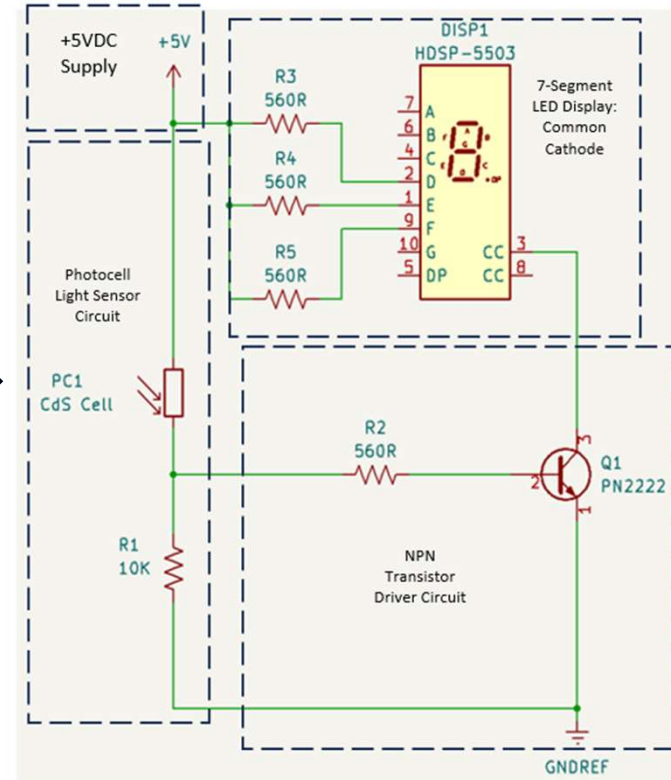
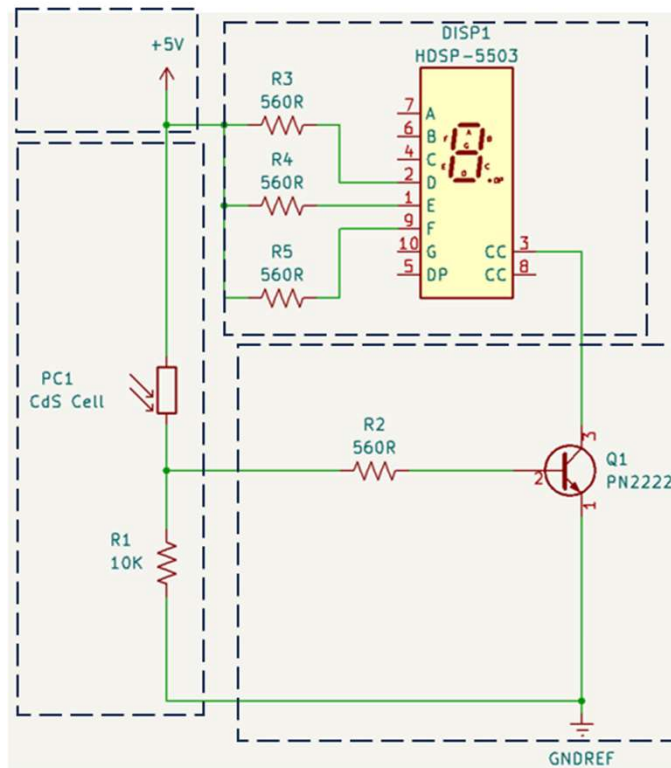
Level 3



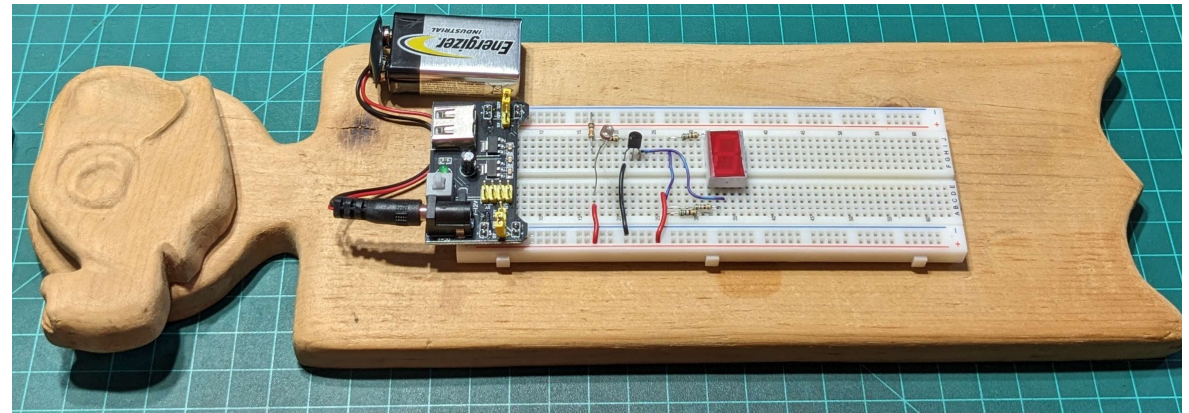
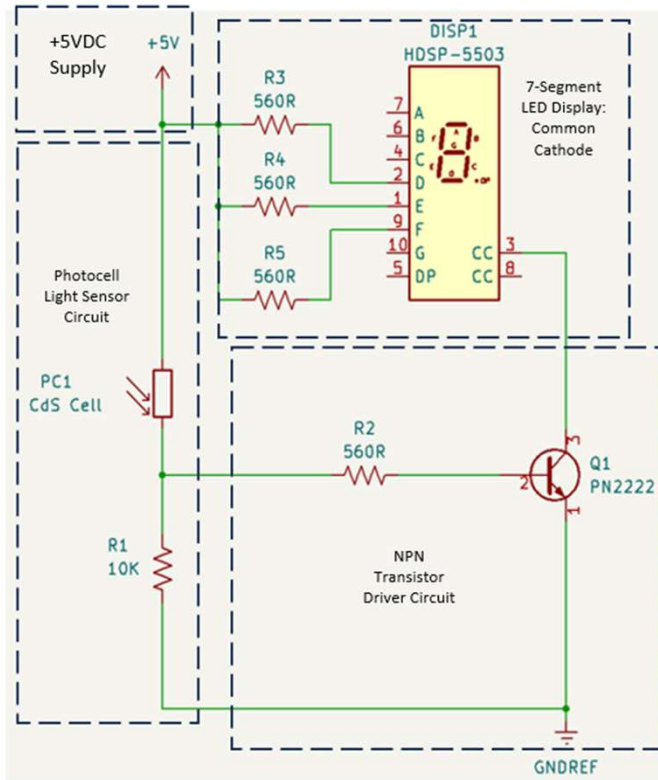
How To Convert a Block Diagram to an Electronic Circuit Schematic Diagram?...



Steps 2 and 3:
Alignment/Partitioning
of Electronic Circuits
with the Block
Diagram and
Documentation



Lab: Build A Light Sensor with a 7 Segment LED Display



Lab: Build A Light Sensor with a 7 Segment LED Display...



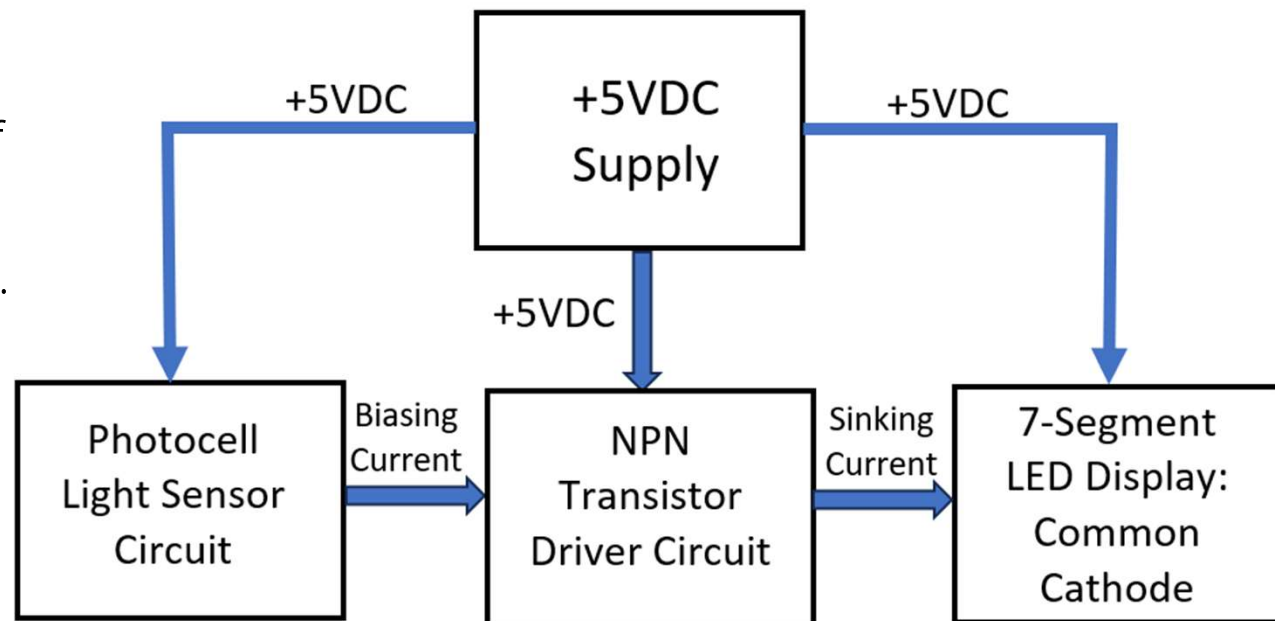
Lab Objectives:

- Participants will learn to capture parts data from a Block Diagram to construct an electronic circuit schematic diagram.
- Participants will learn to organize the wiring tasks in building a Light Sensor with a 7 Segment LED display on a solderless breadboard.
- Participants will wire and test the Light Sensor with a 7 Segment LED Display circuit on a solderless breadboard.

Lab: Build A Light Sensor with a 7 Segment LED Display...



Level 2 Block Diagram and Bill of Materials (BOM) will help to capture parts and organize the wiring tasks for the project build.



Lab: Build A Light Sensor with a 7 Segment LED Display...



Source: E:\DWilcher F\DesignNews\CEC_courses\September_2024\Course_Sessions\Day1\Electronic_Light_Sensor_w_7_Segment_LED_Display\Electronic_Light_Sensor_w_7_Segment_LED_Display.kicad_sch
 Date: #####
 Tool: Eeschema (6.0.4)
 Generator C:\Program Files\KiCad\6.0\bin\scripting\plugins\bom_csv_grouped_by_value.py
 Components 8

Individual Components:

Item	Qty	Reference Value	LibPart	Footprint	Datasheet
		DISP1 HDSP-5503	Display_C Display_7		https://ia800903.us.archive.org/24/items/CTKD1x8K/Cromatek%20D168K.pdf
		PC1 CdS Cell	Device:R_Photo		~
		Q1 PN2222	Device:Q_NPN_EBC		~
		R1 10K	Device:R_US		~
		R2 560R	Device:R_US		~
		R3 560R	Device:R_US		~
		R4 560R	Device:R_US		~
		R5 560R	Device:R_US		~

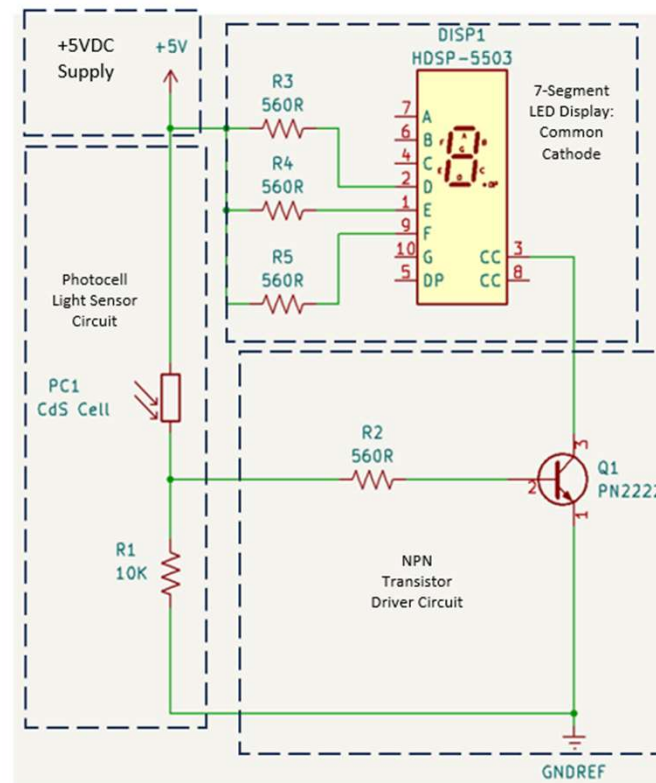
A Bill of Material (BOM) for the Light Sensor with a 7 Segment LED Display project.

Collated Components:

Item	Qty	Reference Value	LibPart	Footprint	Datasheet
1	1	DISP1 HDSP-5503	Display_C Display_7		https://ia800903.us.archive.org/24/items/CTKD1x8K/Cromatek%20D168K.pdf
2	1	PC1 CdS Cell	Device:R_Photo		~
3	1	Q1 PN2222	Device:Q_NPN_EBC		~
4	1	R1 10K	Device:R_US		~
5	4	R2, R3, R4 560R	Device:R_US		~

Lab: Build A Light Sensor with a 7 Segment LED Display...

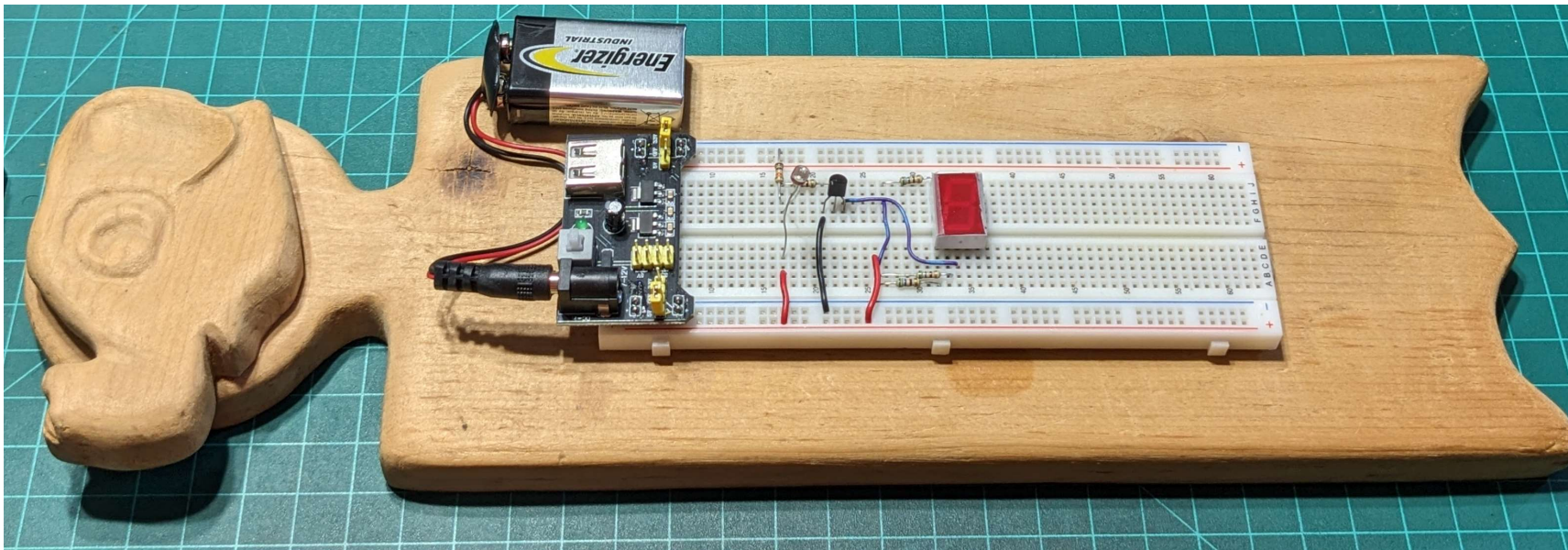
Partitioning the Electronic Circuit Schematic diagram into circuit blocks will aid in the task of electrical wiring on a solderless breadboard.



Lab: Build A Light Sensor with a 7 Segment LED Display...



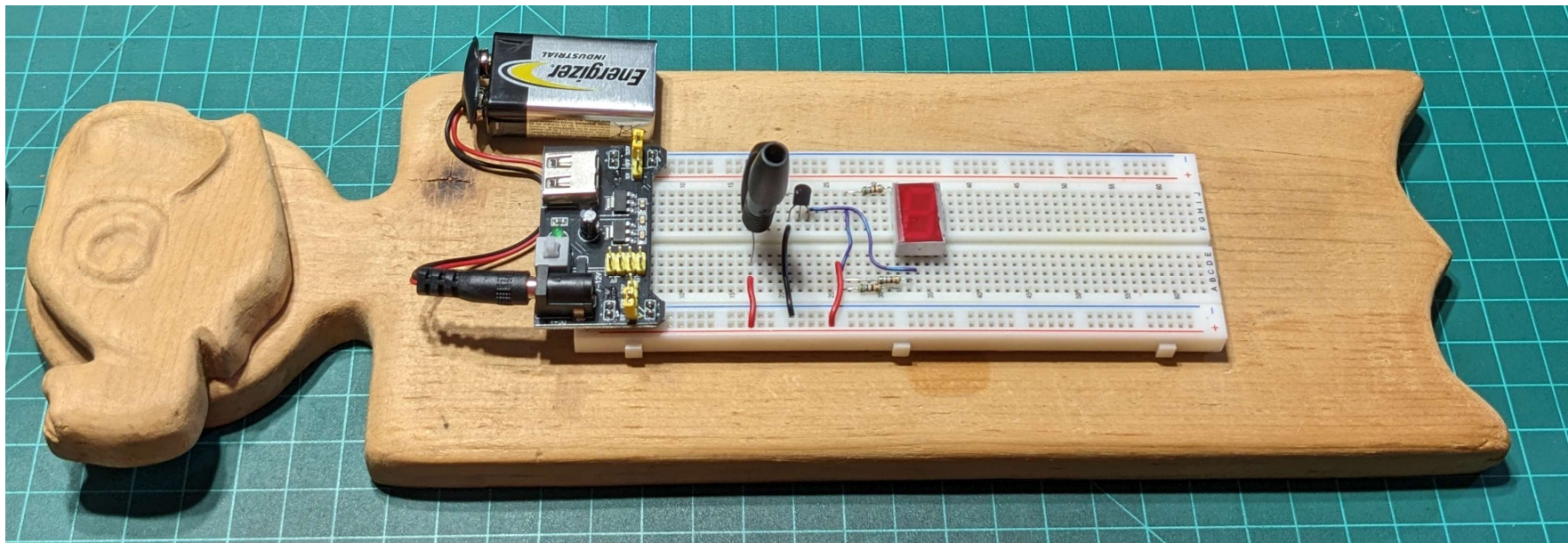
Final Project Build: Solderless Breadboard on an Elephant (E) Breadboard!



Lab: Build A Light Sensor with a 7 Segment LED Display...

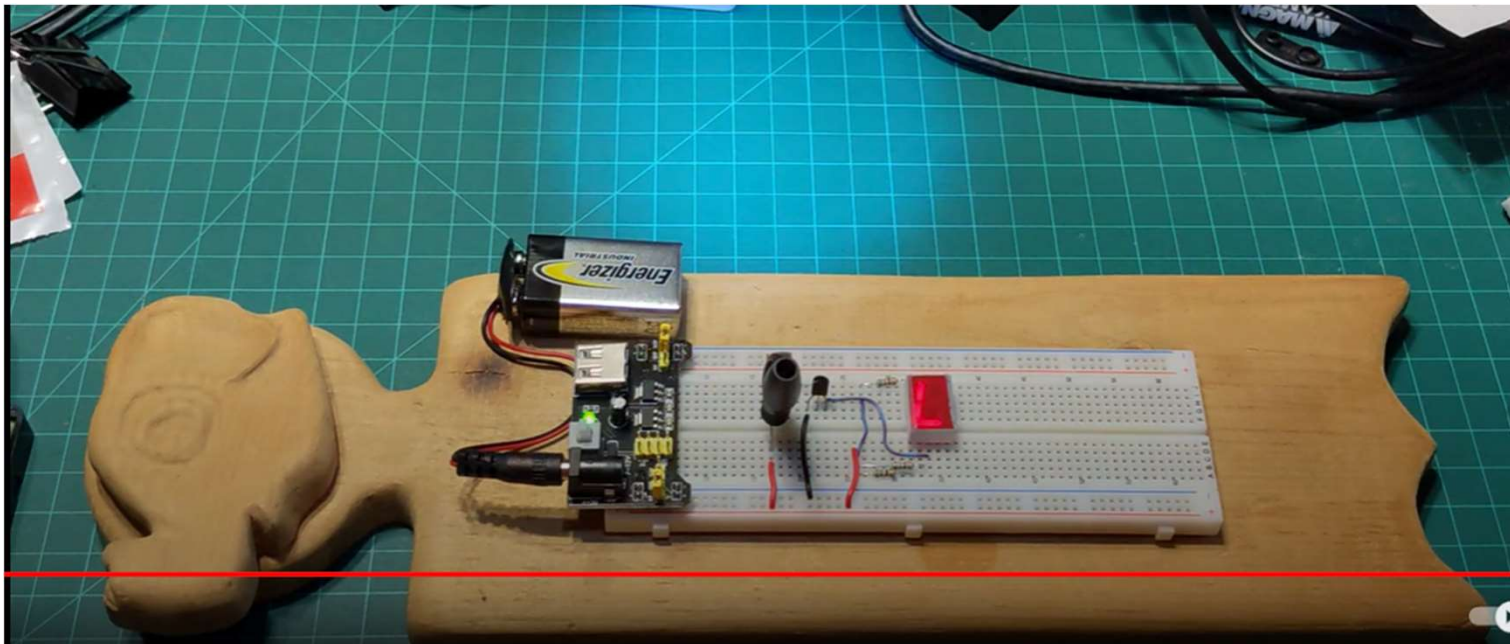


A collimator was added to improve the light detection function of the CdS Photocell.



Lab: Build A Light Sensor with a 7 Segment LED Display...

Watch the YouTube Video clip for the actual operation of the electronic detection circuit.



<https://www.youtube.com/watch?v=Wlv9am4bftw>

Question 5

In reviewing slide 28, which circuit block diagram provides details of electronic components?

- a) Level 0**
- b) Level 1**
- c) Level 2**
- d) Level 3**



Thank you for attending

Please consider the resources below:

The Brainy Insights. (2024, May). *Solderless breadboards market*.

<https://www.thebrainyinsights.com/report/solderless-breadboards-market-14339>

Yan, Z., Zhang, Z., Li, J., & Peng, H. (2023, May 21-16). *SolderlessPCB: Reusing electronic components in pcb prototyping through detachable 3d printed housing* [Conference session].

CHI, Honolulu, HI, United States. <https://arxiv.org/html/2403.18797v1>

Zhu, J., Blumberg, L. G., Zhu, Y., Nisser, M., Carlson, E. L., Wen, X., Shum, K., Ayeley, J., & Mueller, S. (2020, April 25 -30). *CurveBoards: Integrating breadboards into physical objects to prototype function in the context of form* [Conference session]. CHI, Honolulu, HI, United States. <https://dl.acm.org/doi/abs/10.1145/3313831.3376617>



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