

RADIO MAGIC

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Snap Circuits Part 1: Unleash Your Creativity!

Introduction

I fondly remember my first (1973) Radio Shack “Science Fair” 65-in-1 electronic project kit. Its components mounted inside a wooden box on thick colourful cardboard with images/text plus umpteen small spring coil connections (Figure 1).

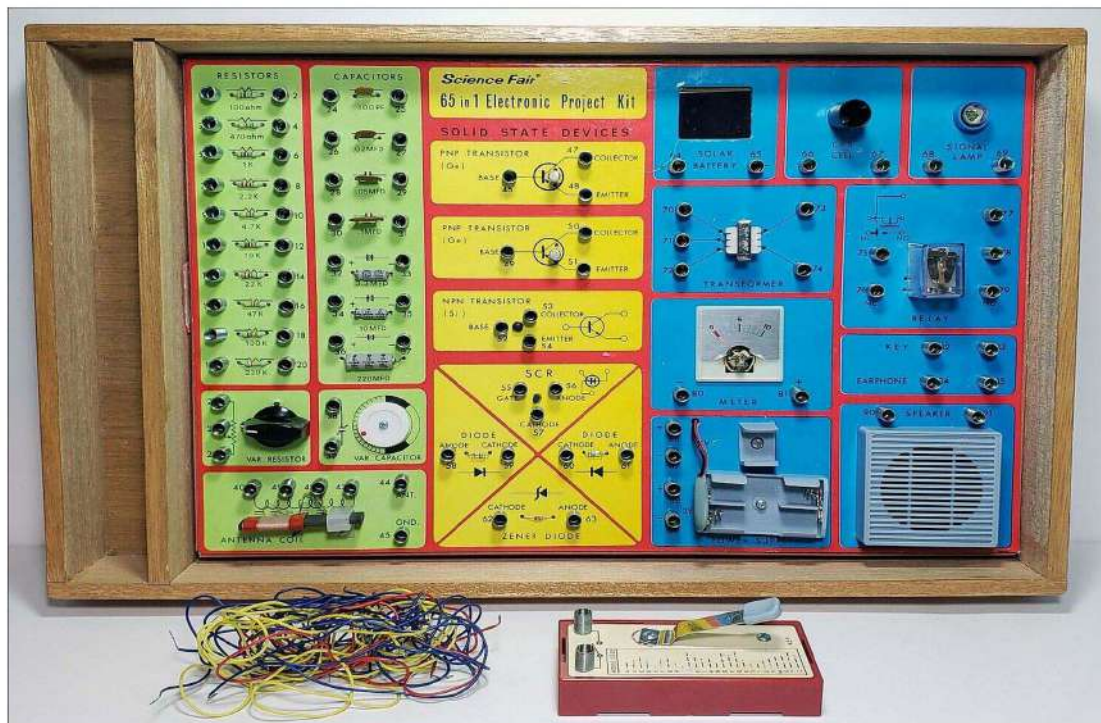


Figure 1: Science Fair 65-in-1 Electronic Projects Kit

Can't remember what happened to mine, but they're still available in good condition on the used market. Image credit: eBay.

Many enjoyable hours were spent building battery powered circuits using various lengths of #22 coloured insulated wires strung from spring coil to spring coil. And sometimes there were so many colourful lengths of intertwined wires that it was often difficult to figure out why a circuit didn't work so it was just easier to take it apart and start over again. Fast forward 50 years later, several LEGO-style building block electric/electronic project kits are available to construct the same basic circuits except components snap together allowing builds in three-dimensions (3D)! Components are no longer fixed in place and can be moved around like jigsaw puzzle pieces, increasing creativity and versatility while minimizing inter-component connection errors and fault finding frustration.

Snap to It!

The most popular on the market (among many clones) is the original called "Snap Circuits" (originally "Snap Kits"). It was introduced in the early 2000s by the family owned/operated US based company Elenco Electronics Inc. Snap Circuits has won many awards over the years and is very popular among educators, hobbyists, students and parents. It's used in classrooms to teach STEAM (science, technology, engineering, art and math) concepts, encouraging students to think outside the box, be more creative instead of copycat, develop problem-solving skills plus they can build and experiment with real-world applications of the subjects they're learning about.

But instead of spring coils and wires, straight acrylic blue links with metal button snaps spaced evenly along various link lengths are used. A large, clear acrylic master base plate has short, non-conductive prongs onto which all components are snapped in place. Electric/electronic parts are mounted on/in larger acrylic base plates of different shapes, sizes and colours with their values/descriptions stamped on the base plates (Figure 2, next page). Because of Elenco's ingenious mounting method, Braille labelling can be put added on their undersides plus components can be snapped on top of others to build circuits vertically and/or horizontally! But we can't get rid of wires altogether and insulated #22 coloured ones of various lengths are available with button snaps at each end plus ones with button snaps at one end and DuPont pins at the other for connecting to external solderless breadboard circuits and/or other devices with DuPont headers. You can also make your own custom 3.5 millimetre mono/stereo jack-to-snap or Anderson pole-to-snap adapters.

Figure 2: Snap Circuits ARCADE (Electronics and Microcontrollers)

This stand-alone kit builds a 3D microcomputer controlled “arcade” with many imaginative pre-programmed games plus with various electric/electronic experiments.



The Snap Circuits product line is designed to make it so much easier for anyone to handle and identify parts by sight or touch regardless of age or physical ability, and learn by building basic, intermediate to advanced electric/electronic circuits. Several kits are specifically designed to be interfaced to microcontrollers (specifically Arduino, PICAXE or BBC micro:bit). Elenco offers variety and versatility from their deluxe and pricey 750-in-one projects kit with custom case and foam cut component compartments (Figure 3, next page) to their less expensive 750-in-1 kit in a colourful cardboard box with plastic parts tray. Or you can start with the less expensive 100-in-1 projects kit then add the separate 300, 500 and 750-in-1 plus computer interface upgrades as you progress. Alternatively, even less expensive single subject snap kits (Figure 4, next page) are also available. To help decide, you can download the various Snap Circuits kit manuals and compare them to see which kits are applicable to your current/future electric/electronic or microcontroller STEAM learning needs for home, school, group or club use.

You can purchase most Snap Circuits kits including replacement and ancillary parts from RobotShop Canada plus some full kits from other Canadian suppliers or directly from Elenco albeit they charge a hefty cross-border shipping fee and only ship via UPS (add additional broker fees). Elenco has produced excellent free-to-download student and teacher's Snap Circuits guides that go into more technical details in exploring and explaining electric/electronic concepts than the come-with kit manuals do.

Figure 3: Snap Circuits Pro 750-in-1 w/Computer Interface in Custom Case
Buy the entire package in one shot or start out small then add upgrade kits later on.



Figure 4: Electromagnetism Snap Kit

Inexpensive and basic, but it can be “spiced” up by adding a simple Hall sensor (after physicist Edwin Hall). The Hall sensor detects and converts magnetic fields we can’t feel or see into electric signals that we can use as a proxy.

Imagine; Design; Build

Elenco has added Bluetooth capability to their latest microcontroller snap kits including a free smartphone app for coding and remote control using the powerful and versatile PICAXE 20M2+ by Revolution Education Ltd. Strangely, their Bluetooth enabled microcontroller “DISCOVER CODING” and “EXPLORE CODING” kits only have output ports so it’s a crippled processor (IMHO) because it can’t accept real-world inputs from external analog/digital devices. However, the microcontroller can control several servo motors and this is used effectively in Elenco’s 4-wheeled robotic rover “CODE JOURNEY” snap kit (Figure 5). Use it to autonomously explore the “Martian” surface (backyard or schoolyard) carrying a smartphone and live-streaming video.

Figure 5: Snap Circuits Code Journey

Microcontroller Rover

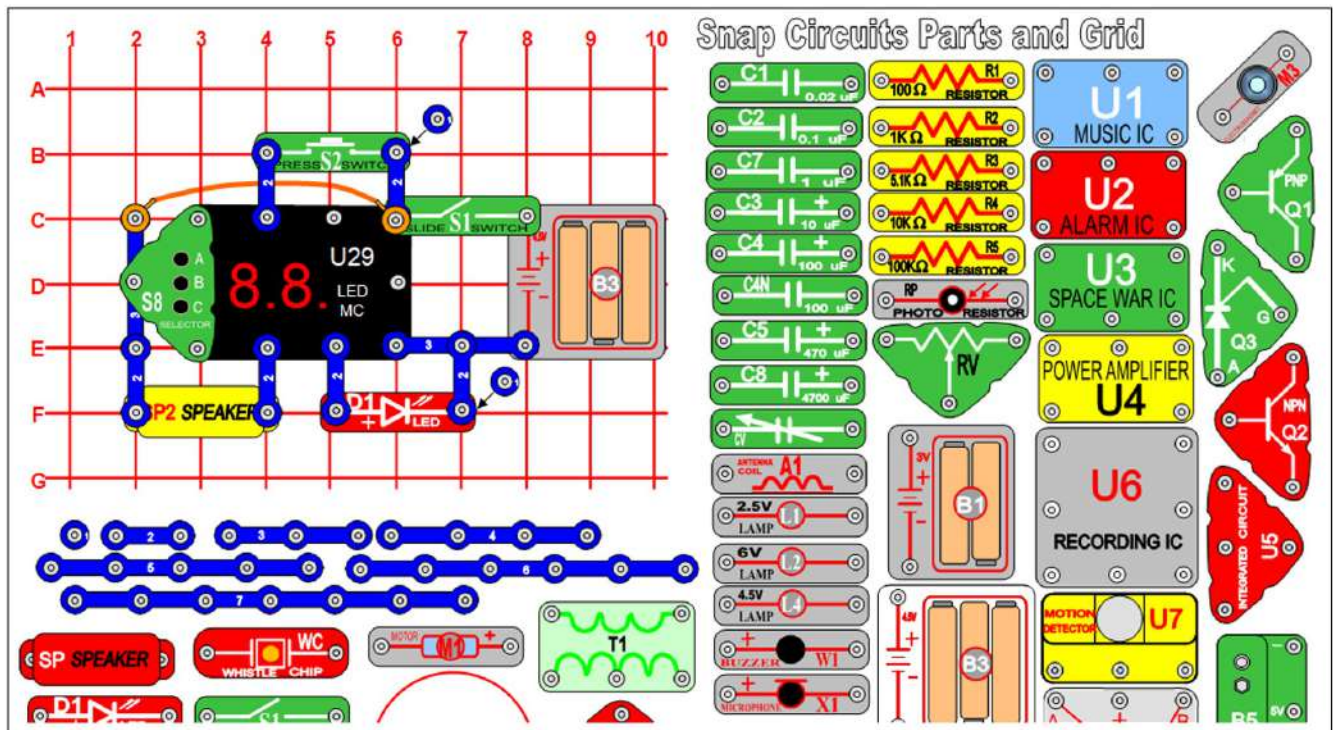
Robotics is a very interesting area of engineering and exploration by using a microcontroller to give autonomous artificial intelligence (AI) control to various robotic devices. This is very critical when your rover is several hundred million kilometres away from home!



Some “imagers” may want to enhance existing or create new circuits and post their designs online for others to use. Elenco has created a “Designer Showcase” webpage as well as a free MS Word (only) “Designer Template” (Figure 6, next page). Virtual circuit simulation isn’t possible so you’ll have to build the actual proof-of-concept snap circuit then “tune for smoke” to see if it works or goes poof! Been there, done that.

Figure 6: Morse CPO Designer Template Example

Once you create your design, it's easy to build the real-world, 3D snap circuit. Almost every snap component is available but only a small portion is depicted here.

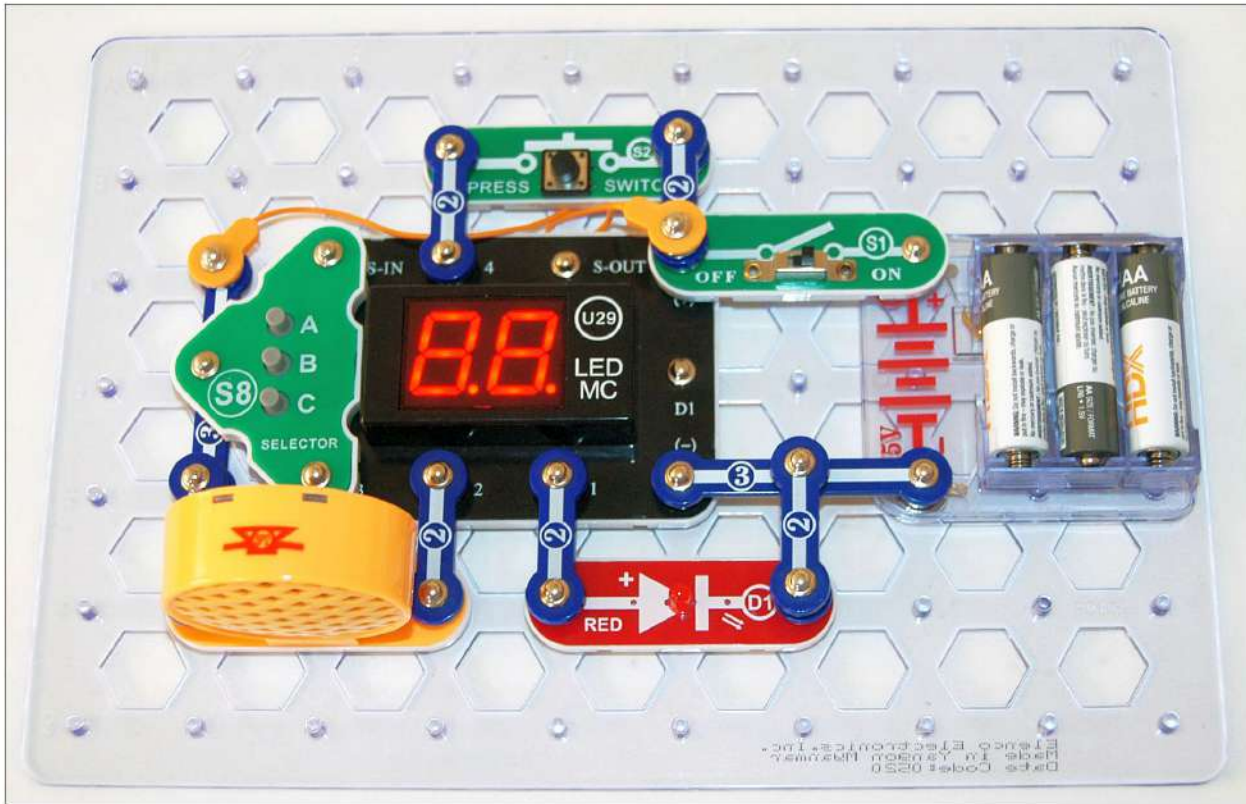


The Black Box and Blockly

Elenco developed their 3D ARCADE snap kit around a specially customized, pre-programmed PICAXE 08M2+ LED MC (part U29) microcontroller having both user accessible input/output analog/digital data ports. There's a lot of cool circuitry hidden within a large, shiny black acrylic housing and a younger version of me would have immediately cracked it open to have a look "under the hood". Fortunately, for the microcontroller, Elenco supplies the black box schematic plus the undocumented (for the most part) PICAXE BASIC "spaghetti" source code (only 625 lines). So I put the hammer away and built some ARCADE projects then reverse engineered the source code to learn the hidden "magic" behind its "tricks". Some of the coding is ingenious and I learned a few new PICAXE programming magic tricks.

Figure 7: Snap Circuits Meets Mr. Morse

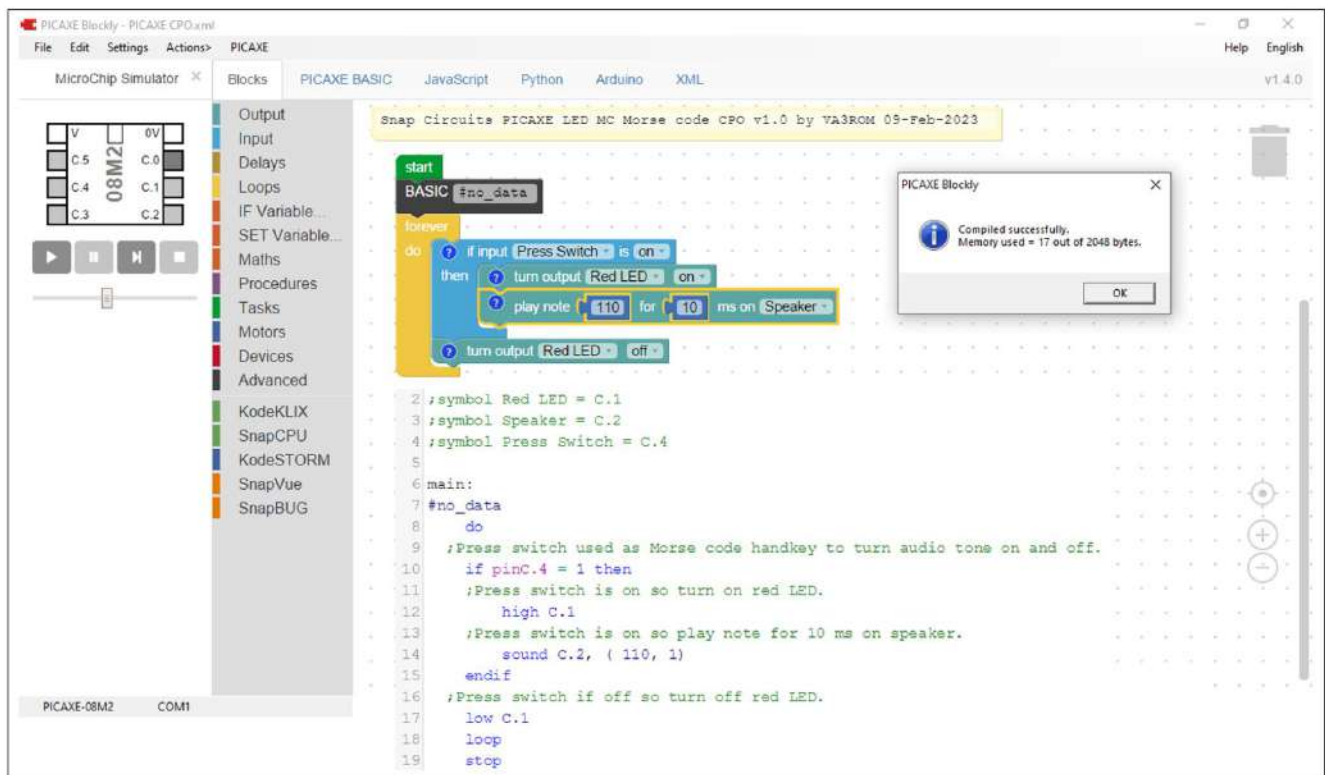
Using only components available in the Snap Circuits ARCADE kit, a rudimentary Morse code practise oscillator (CPO) and code trainer can be designed, built and programmed.



With reference to Figure 7 (above), my Morse CPO gadget-in-waiting can't do much of anything except look good as electronic wall art until a program is loaded into its random access memory (RAM) with the precise step-by-step instructions. The old programmer's axiom "garbage in, garbage out" (GIGO) often causes problems for novices when they're first learning to code in any programming language. Fortunately, there's a graphical object oriented programming (OOP) platform called "Blockly", which was developed in 2011 by a team of Google Corporation programmers. PICAXE Blockly is Revolution Education Ltd's variant for their line of amazing PICAXE microcontrollers (see Figure 8, next page) plus there're also standalone computer and internet (cloud) based versions for the Arduino microcontrollers. In short, Blockly makes programming a snap for novices because it checks for any errors plus it can run simple virtual world input/output simulations. Blockly can also translate blocks into the equivalent syntax used by several other coding languages. I've often used Blockly to learn the actual step-by-step coding used by various black box blocks.

Figure 8: PICAXE Blockly Coding Example

Only a few blocks are required to code a very simple Morse CPO. Blockly converted these blocks into the equivalent PICAXE BASIC line code depicted below the blocks.



The screenshot displays the PICAXE Blockly IDE. The main workspace shows a Blockly block diagram for a Morse code program. The code is as follows:

```
2 ;symbol Red LED = C.1
3 ;symbol Speaker = C.2
4 ;symbol Press Switch = C.4
5
6 main:
7 #no_data
8 do
9 ;Press switch used as Morse code handkey to turn audio tone on and off.
10 if pinC.4 = 1 then
11 ;Press switch is on so turn on red LED.
12 high C.1
13 ;Press switch is on so play note for 10 ms on speaker.
14 sound C.2, ( 110, 1)
15 endif
16 ;Press switch if off so turn off red LED.
17 low C.1
18 loop
19 stop
```

A small dialog box in the upper right corner of the IDE displays the message: "Compiled successfully. Memory used = 17 out of 2048 bytes." The status bar at the bottom of the IDE shows "PICAXE-08M2" and "COM1".

For the AFOL in All of Us

Last but not least, for all the adult fans of LEGO (AFOL) out there, Elenco created a special “Bric2Snap” adapter and compatible LEGO Bricks base plate for their BRIC: STRUCTURE kit. You can easily interface many LEGO (and clones) builds with other snap kits to add motion, sound and light effects or even microcontroller LEGO robotics using servo motors to bring static builds to life.

My Final

Part 2 continues on with the Snap Circuits ARCADE Morse code basic CPO by adding more features and functions. I’ll also cover the genesis of original Morse code to its modern International Morse code variant, which is colloquially called “CW” (continuous wave) by Radio Amateurs. Even though Morse code is no longer a mandatory must-have requirement to become an Amateur, it’s still voluntarily learned and used by a large percentage of Amateurs.—73

References and Resources

ABRA Electronics <https://tinyurl.com/mr2ynaxb>

Blockly for Arduino (web based) <https://tinyurl.com/5n85z3nc>

Blockly for PICAXE (computer based) <https://tinyurl.com/4m4k2rpc>

Blockly for PICAXE (web based) <https://picaxecloud.com>

LEGO <https://www.LEGO.com/en-ca>

micro:bit <https://microbit.org>

PICAXE (Revolution Education Ltd.) <https://rev-ed.co.uk>

Robotics Education <https://robotixeducation.ca>

RobotShop <https://ca.robotshop.com>

Sayal Electronics <https://shop.sayal.com>

Snap Circuits <https://tinyurl.com/2p84je9r>

Snap Circuits Designer Showcase <https://tinyurl.com/bddsh8m5>

Snap Circuits e-Learning (PDF) Guides <https://www.elenco.com/e-learning>

Snap Circuits Product Manuals <https://www.elenco.com/manuals>

Snap Circuits YouTube Videos <https://tinyurl.com/mrxkwuh2>