

## Examples: Version 10.1

This is a collection of diagrams the author has had occasion to produce using m4 circuit macros and others, and dpic or gpic. In some cases there are other or better m4 or pic constructs for producing the same drawings, but names of the actual source-files are shown for reference. Some of the later examples test the boundaries of what can be done when employing a “little language” like pic. Most of the examples can be processed using either dpic -p, dpic -g, or, with exceptions, gpic -t, but the possibility of other postprocessing has meant that sometimes the source is slightly more complicated than it would be if only one workflow had been assumed. The most simplicity and elegance is achieved by sticking to one pic interpreter and one postprocessor.

This document duplicates a few diagrams from the manual Circuit\_macros.pdf. There are also a few files in the examples directory that are not included in this document. To process *file.m4*, for example, type “make *file.pdf*”.

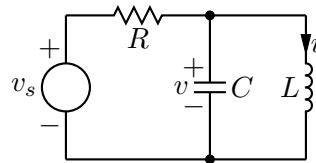


Figure 1: The quick-start example from the manual [quick.m4].

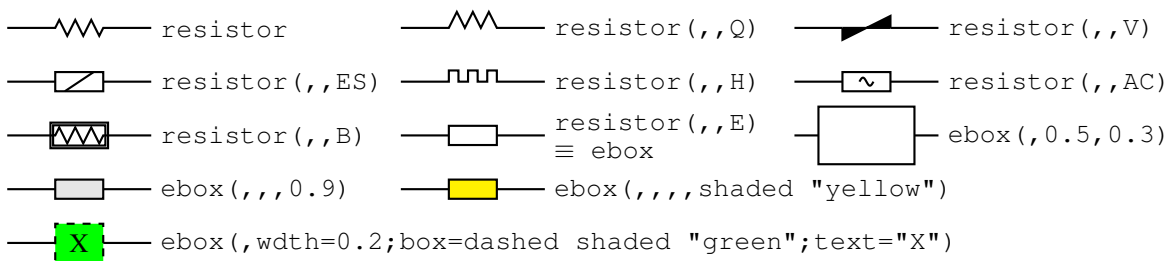


Figure 2: Resistors, showing some variations and the ebox [Resistors.m4].

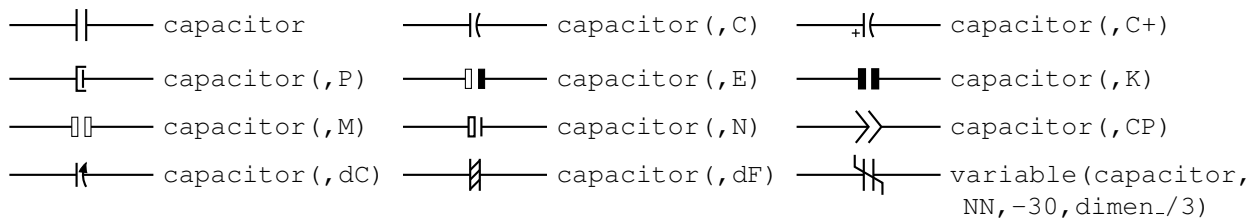


Figure 3: Capacitors [Capacitors.m4].

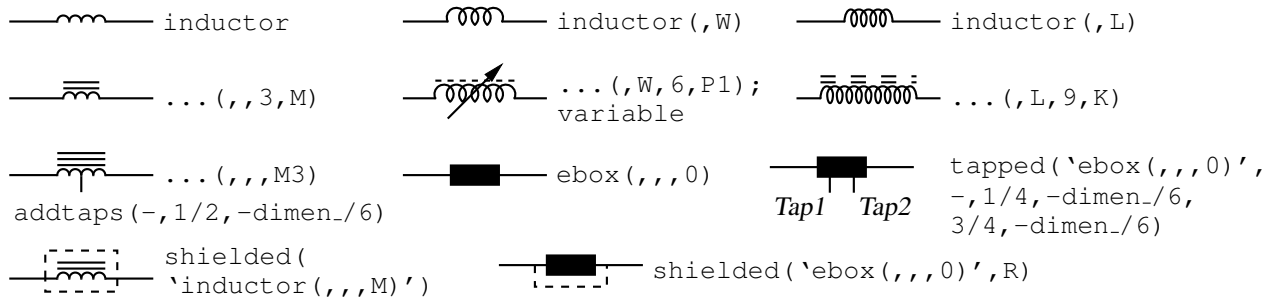


Figure 4: Inductors [Inductors.m4].

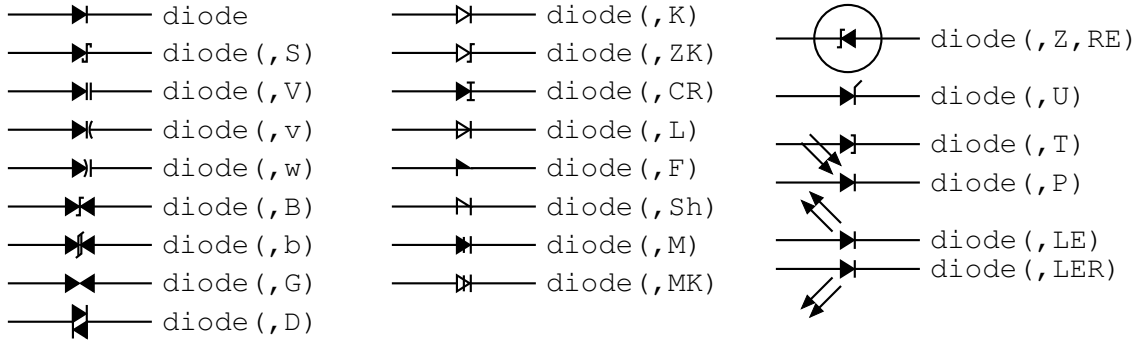


Figure 5: Diodes: appending a K to the second argument draws an open arrowhead [Diodes.m4].

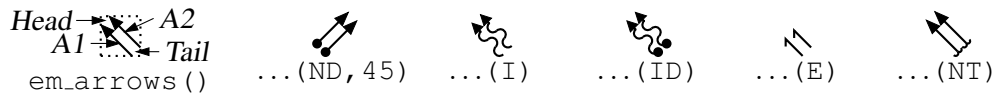


Figure 6: Radiation arrows [Emarrows.m4].

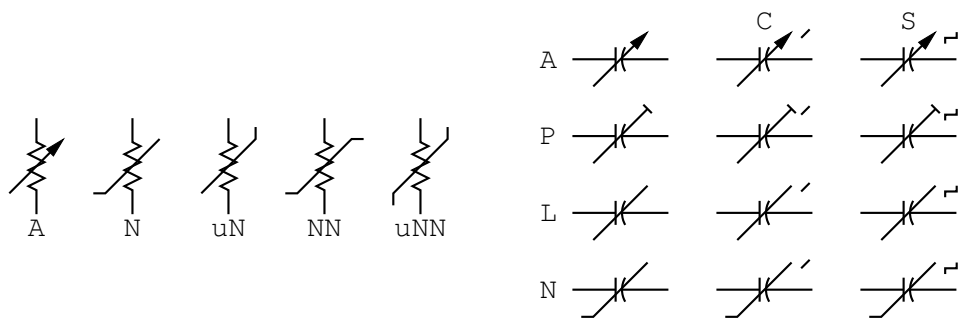


Figure 7: Arrows and marks for showing variability [Variable.m4].

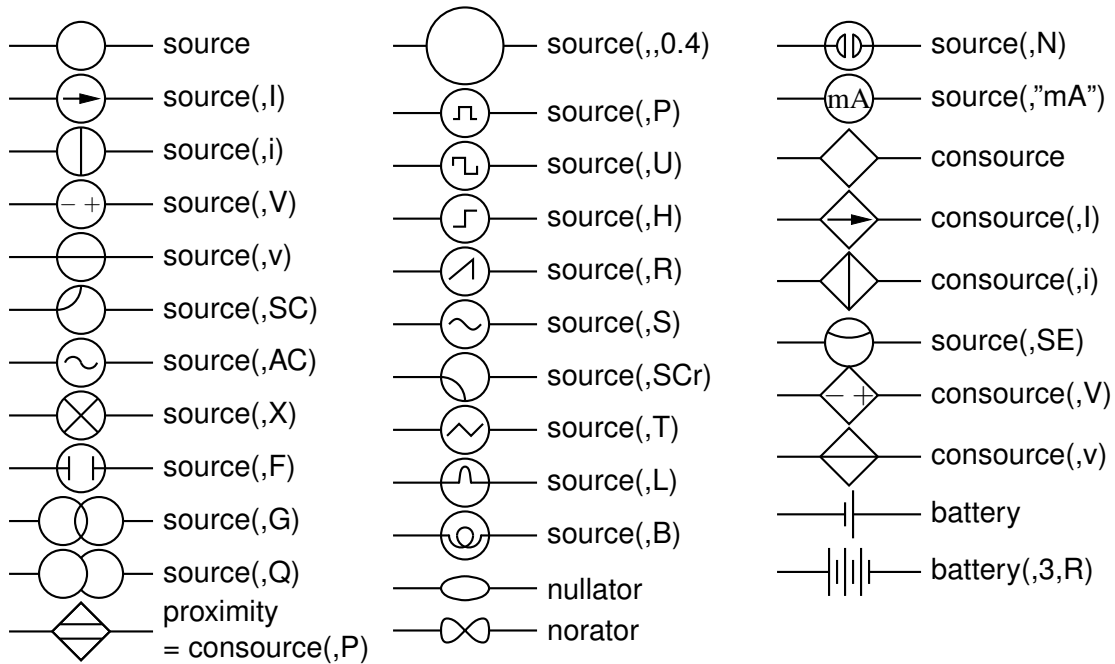


Figure 8: Sources and source-like elements [Sources.m4].

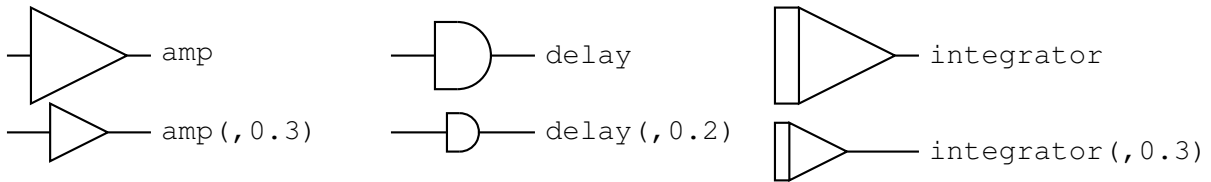


Figure 9: Macros amp, delay, and integrator [AmpTable.m4].

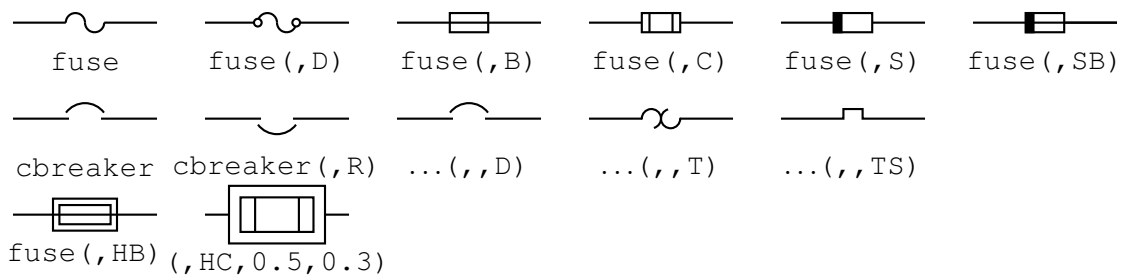


Figure 10: Macros fuse and cbreaker [Fuses.m4].

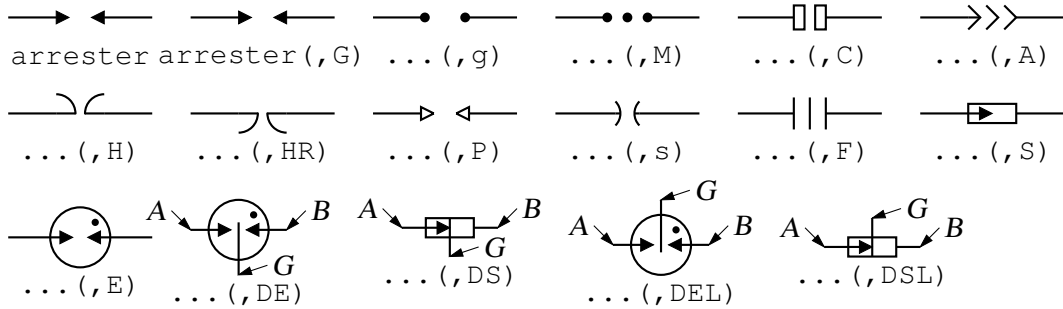


Figure 11: The arrester macro [Arresters.m4].

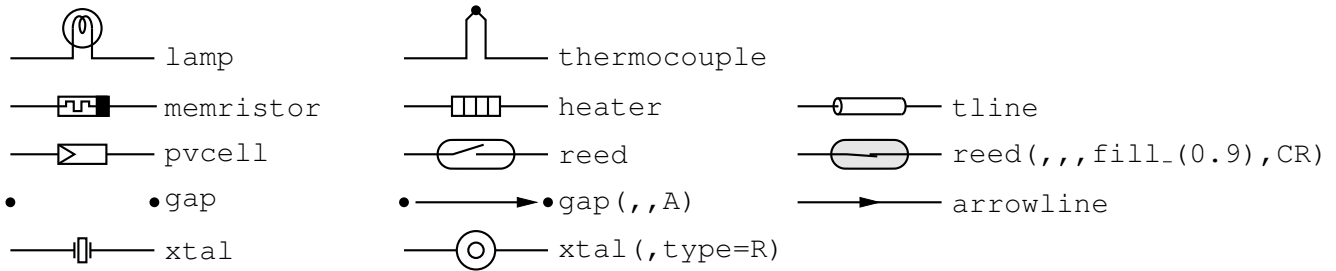


Figure 12: Additional two-terminal elements [MoreTable.m4].

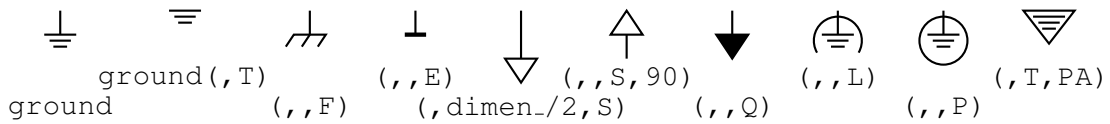


Figure 13: Ground symbols [Grounds.m4].



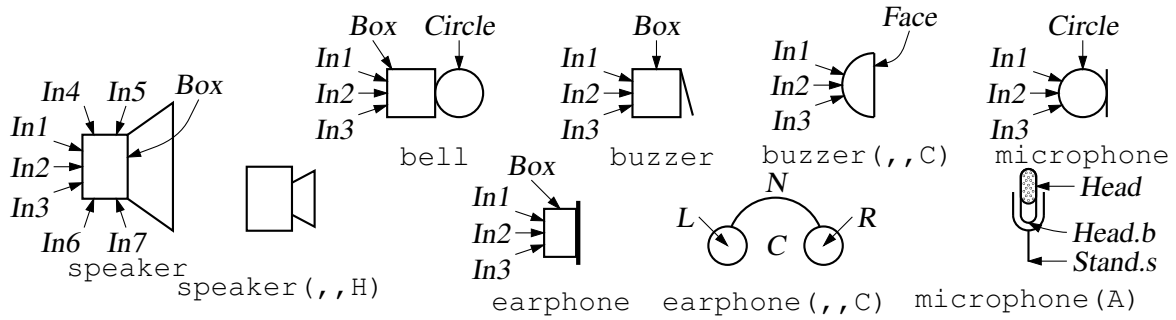


Figure 17: Audio elements [Audio.m4].

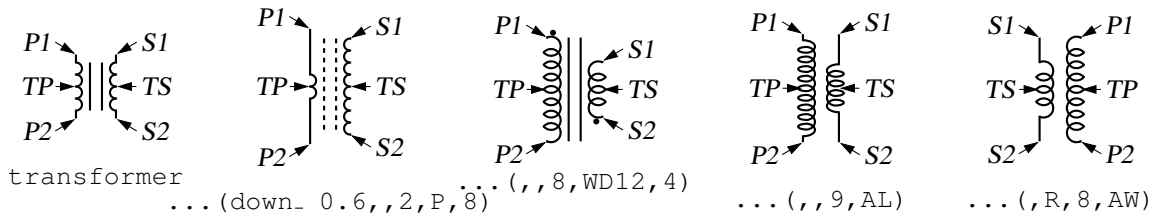


Figure 18: Some variations of the transformer element, drawing direction down [Xform.m4].

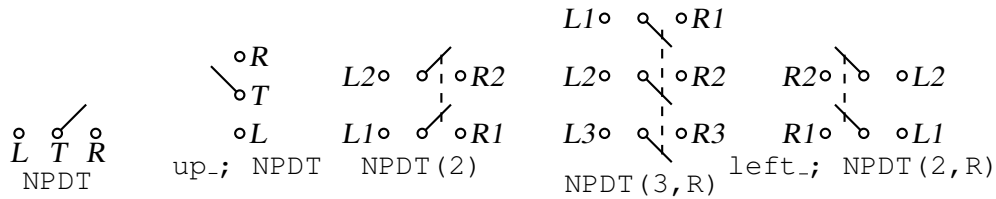


Figure 19: Double throw with the NPDT macro [NPDT.m4].

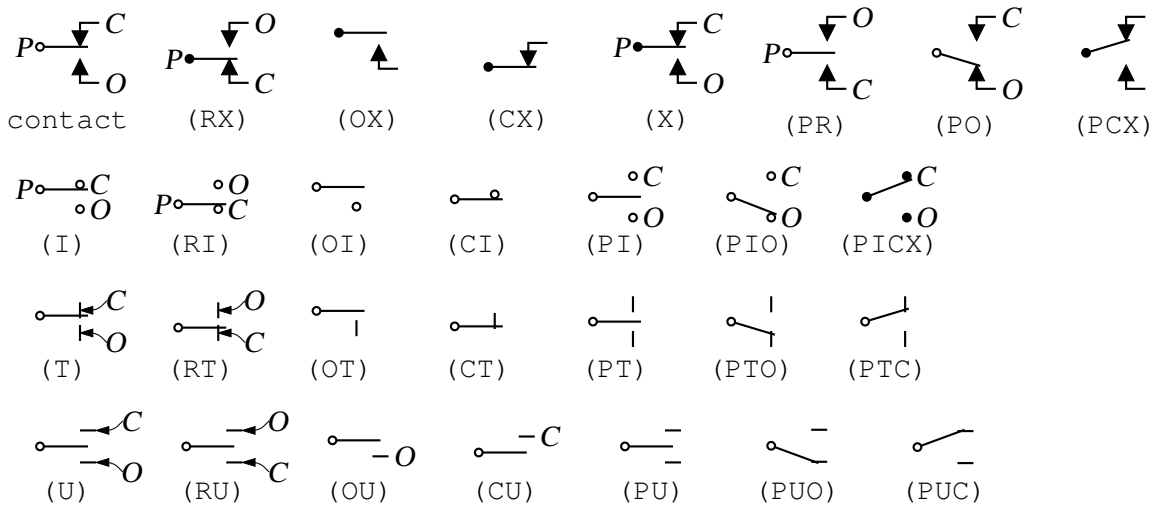


Figure 20: A non-exhaustive sampling of contact macro variations [Contact.m4].

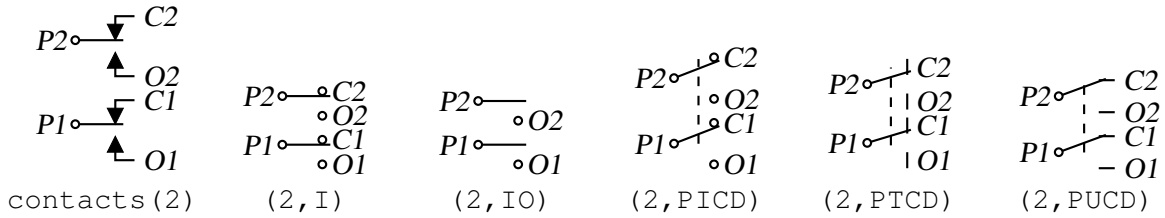


Figure 21: The contacts macro [Contacts.m4].

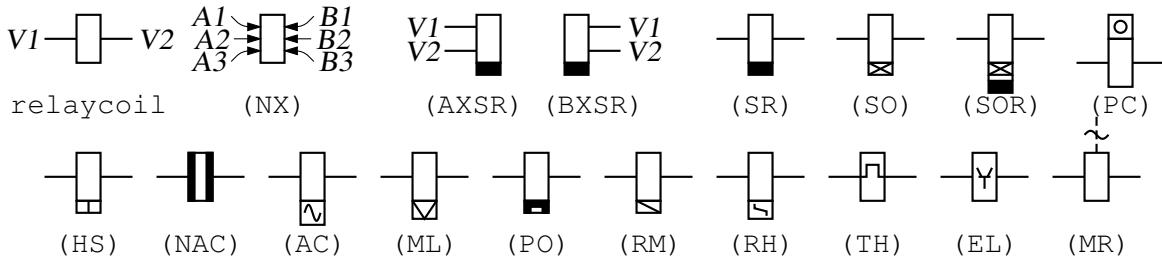


Figure 22: The relaycoil macro [relaycoil.m4].

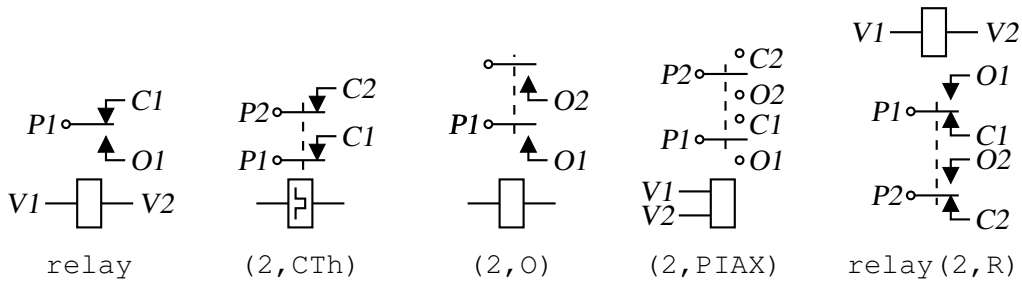


Figure 23: Some variants of relay [Relay.m4].

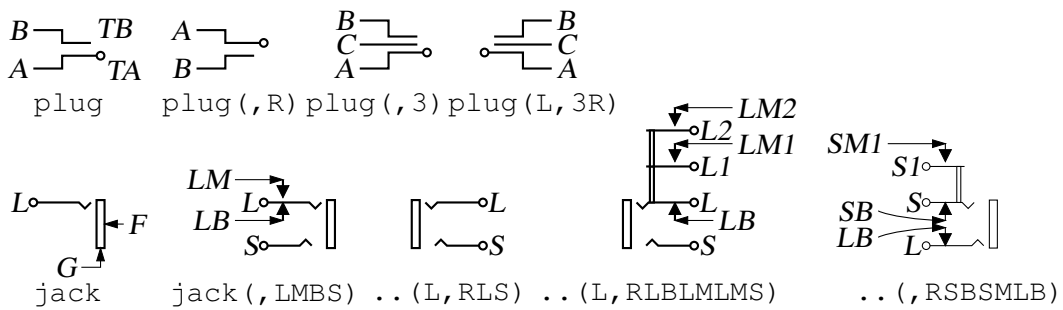


Figure 24: The jack and plug macros [Jack.m4].

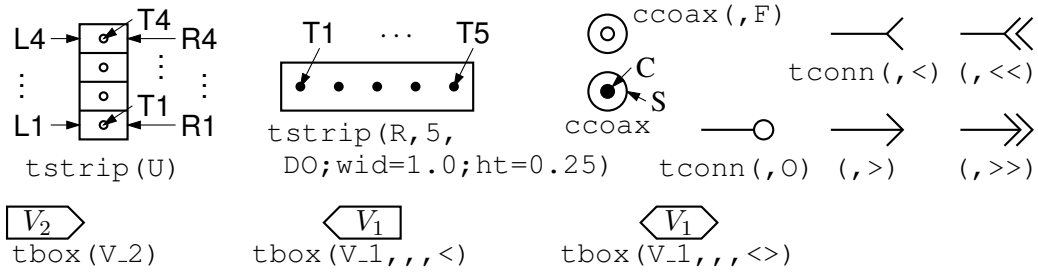


Figure 25: The tstrip, ccoax, tconn, and tbox macros [Conn.m4].

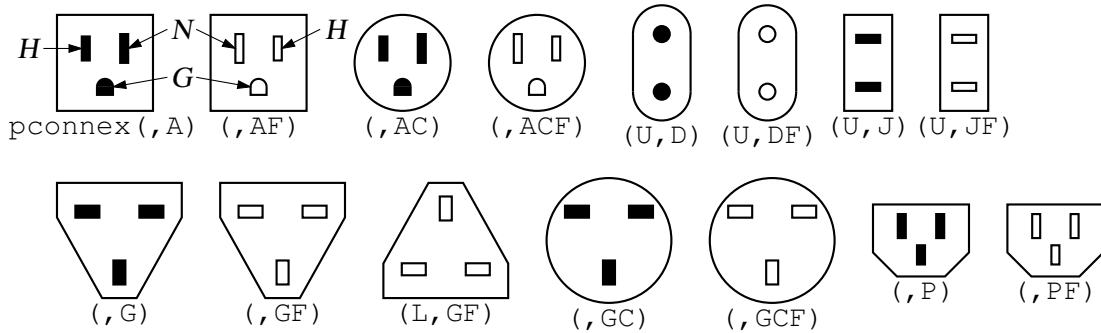


Figure 26: The pconnex macro [Pconn.m4].

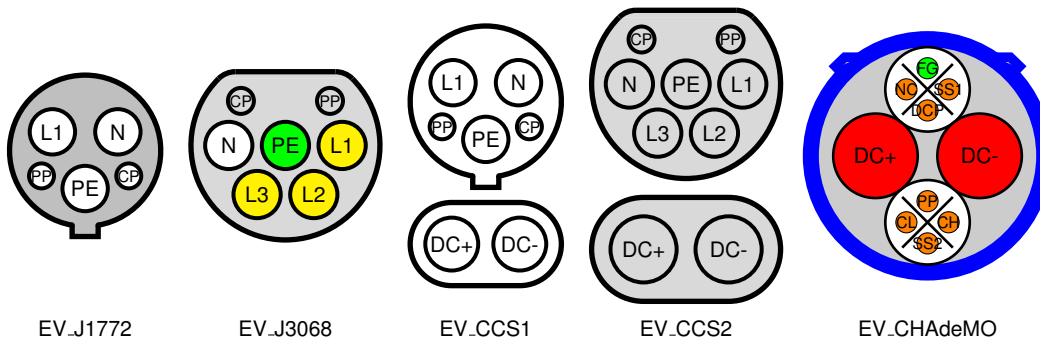


Figure 27: Electric vehicle charging plug patterns make extensive use of key=value pairs to set options [EVplugs.m4].

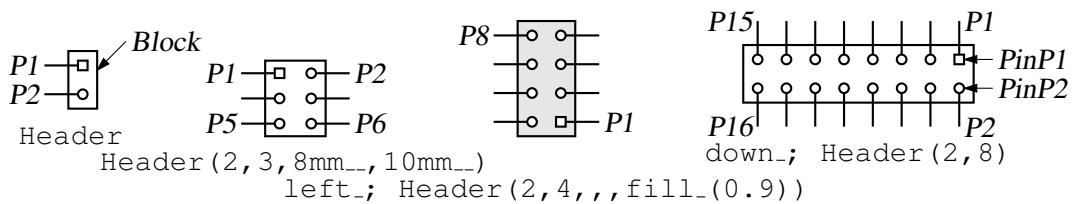


Figure 28: The Header macro [Headers.m4].



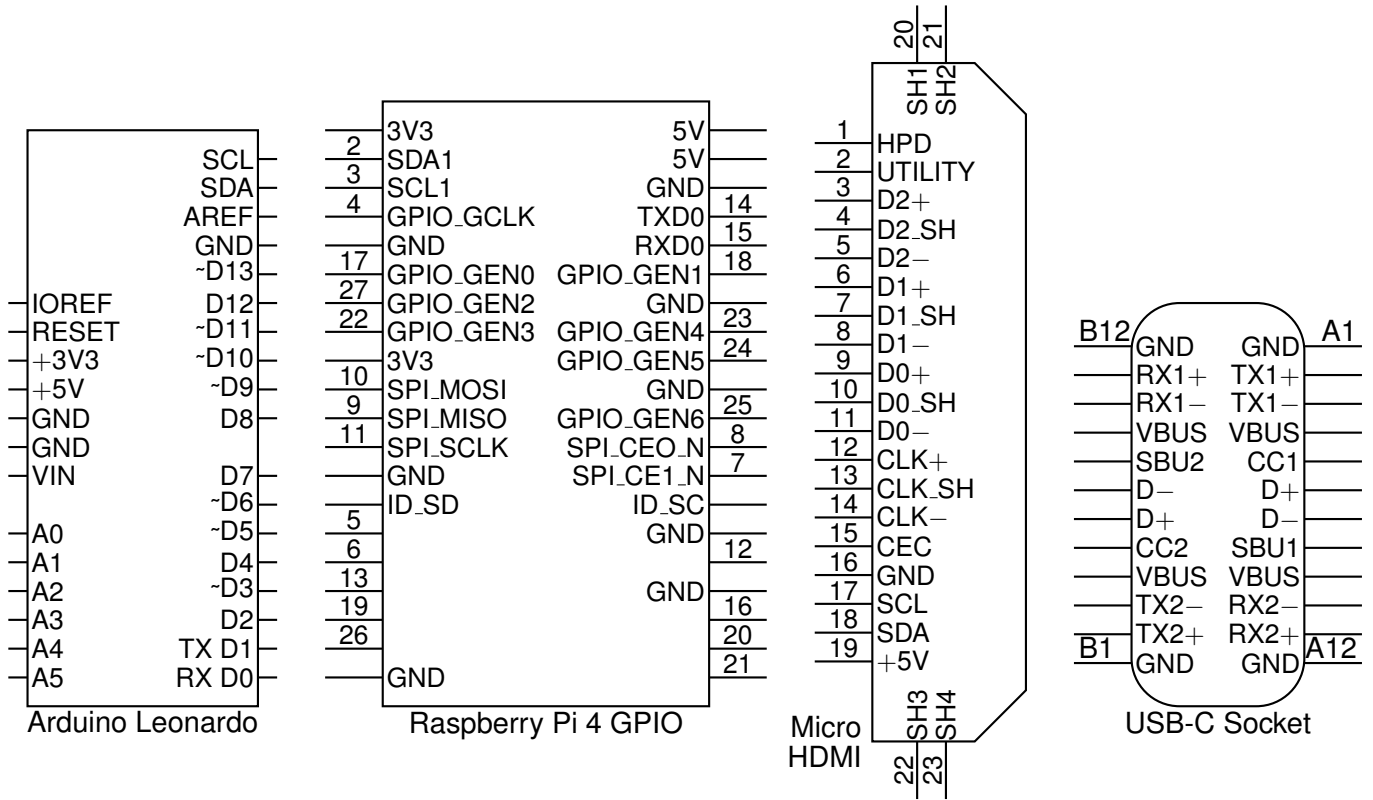


Figure 29: Some connectors with simple geometry and lists of labels [Connectors.m4].

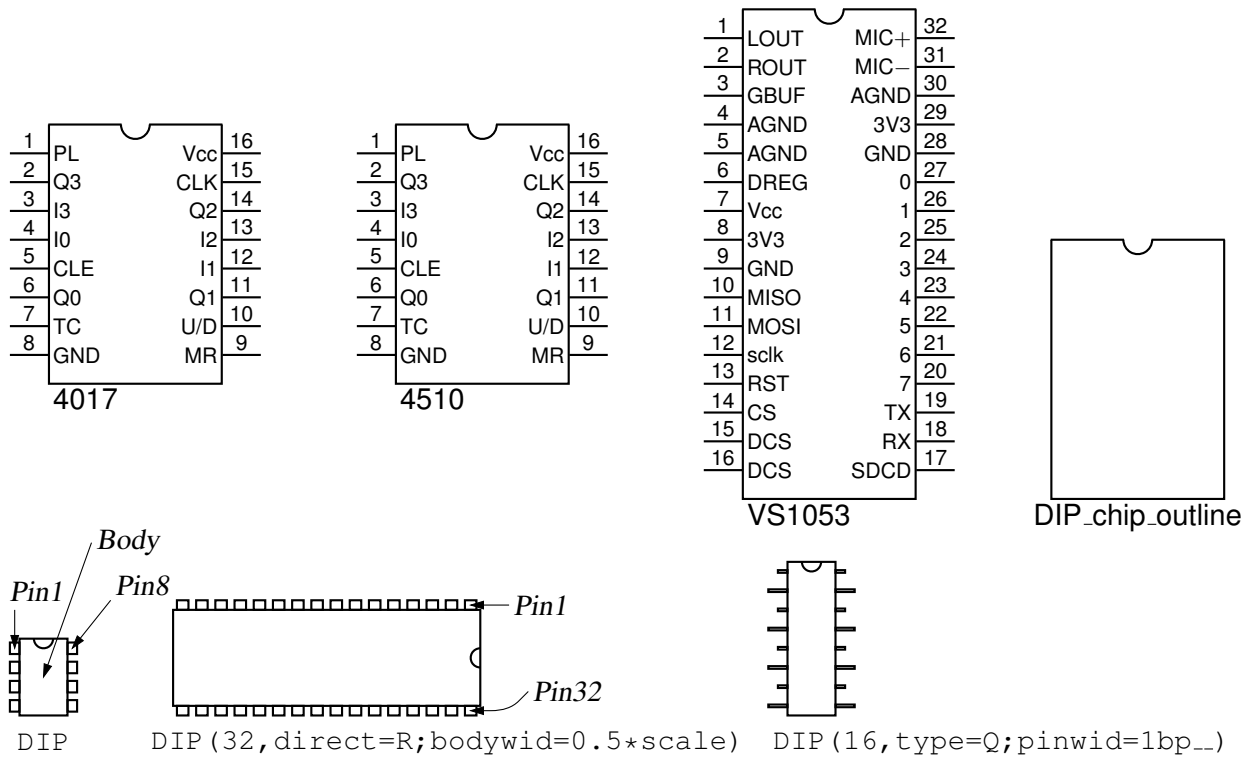


Figure 30: IC package outlines [Chips.m4].

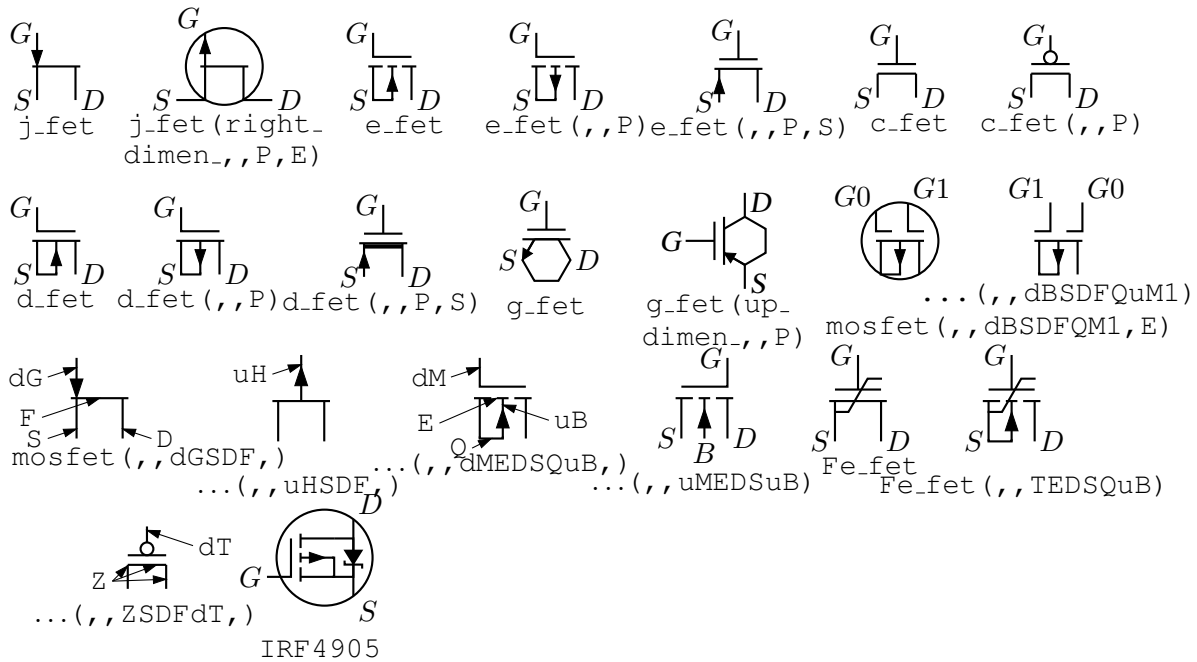


Figure 31: FETs, showing programmable components and example customizations [fet.m4].

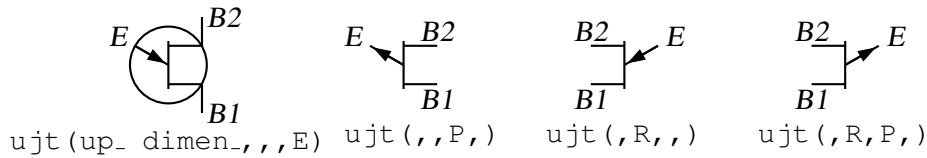


Figure 32: UJT examples [ujt.m4].

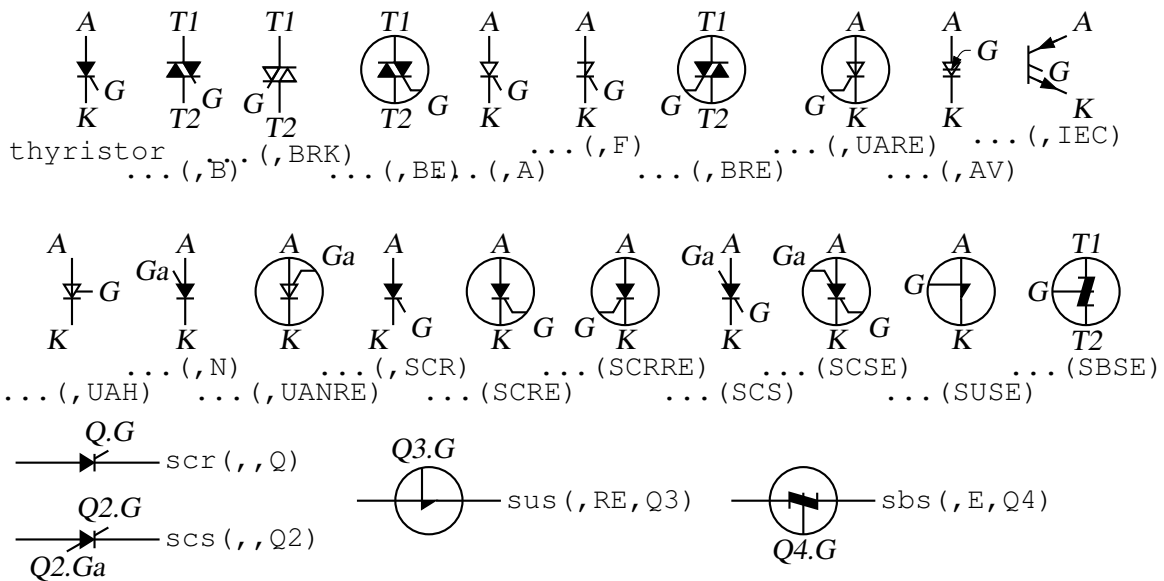


Figure 33: Thyristor examples. The thyristor is a 3- or 4-terminal composite element [thyristor.m4].

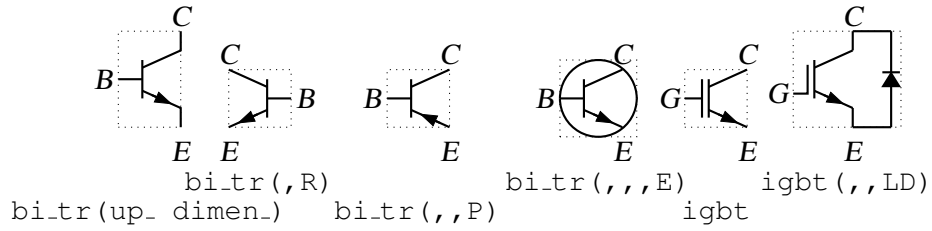


Figure 34: Bipolar transistors (drawing direction: up) [Bip.m4].

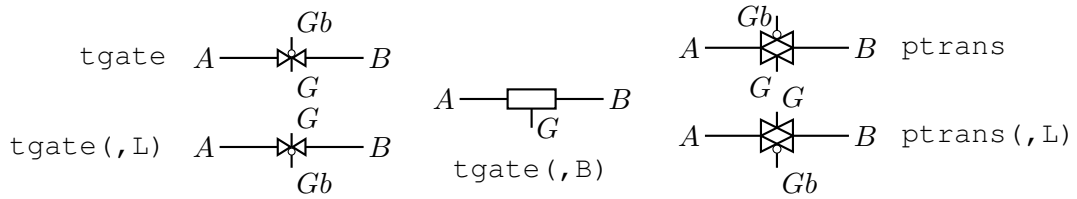


Figure 35: The tgate and ptrans elements [Tgate.m4].

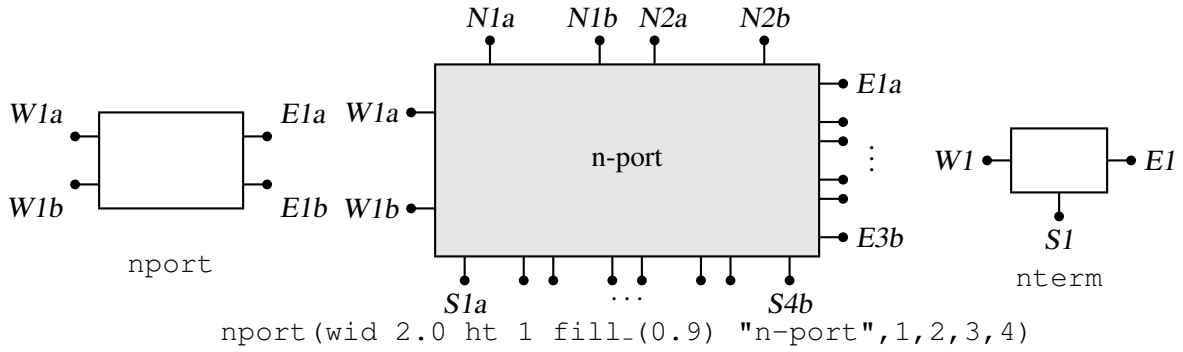


Figure 36: The nport and nterm macros [Nport.m4].

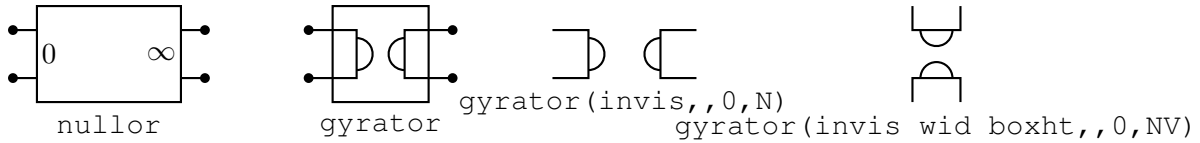


Figure 37: Some customizations of nport [NLG.m4].

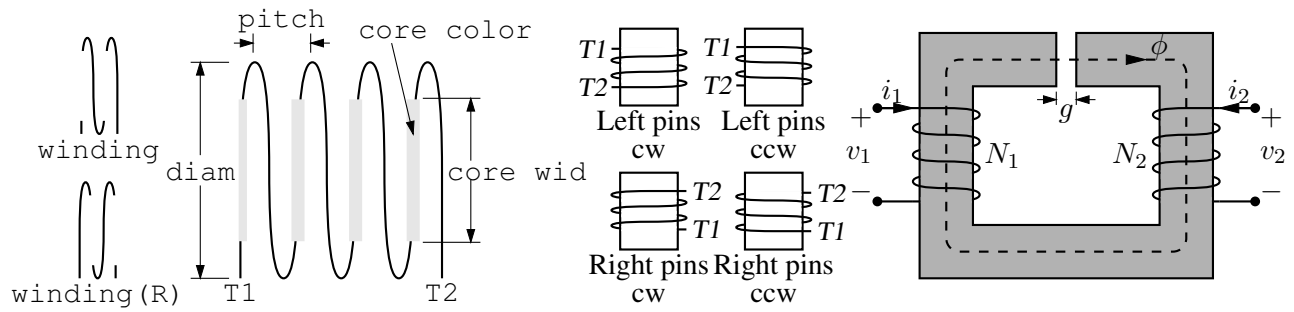


Figure 38: The macro winding (L|R, diam, pitch, turns, core wid, core color) [Windings.m4].

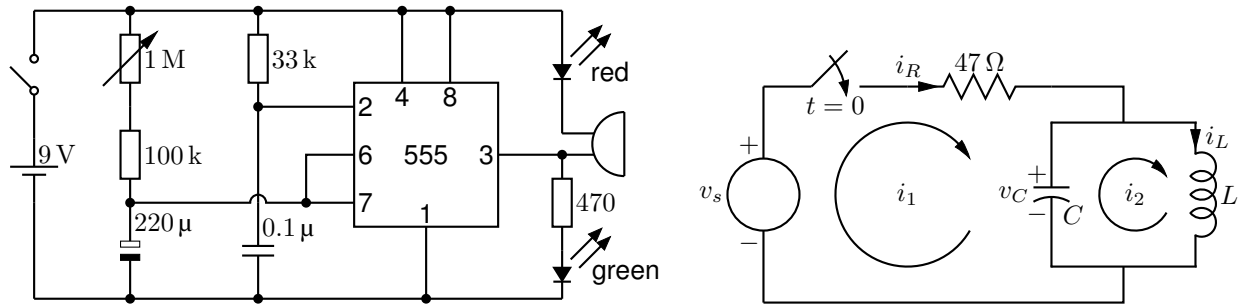


Figure 39: Two simple labeled circuits [ex01.m4].

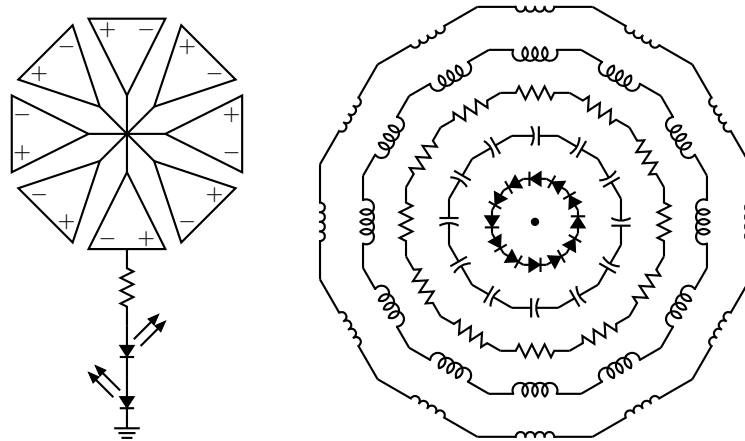


Figure 40: Elements at obtuse angles [ex02.m4].

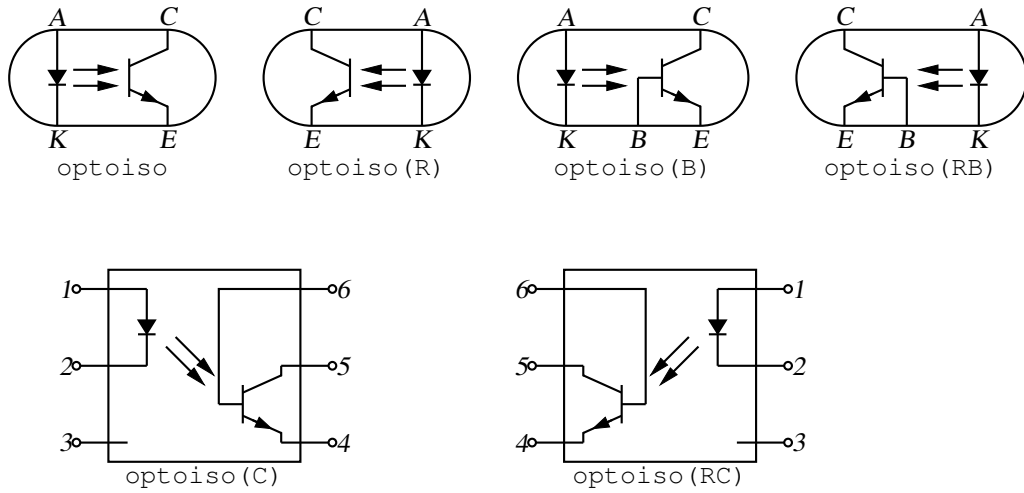


Figure 41: Optical isolator: a circuit with right or left orientation [Optoiso.m4].

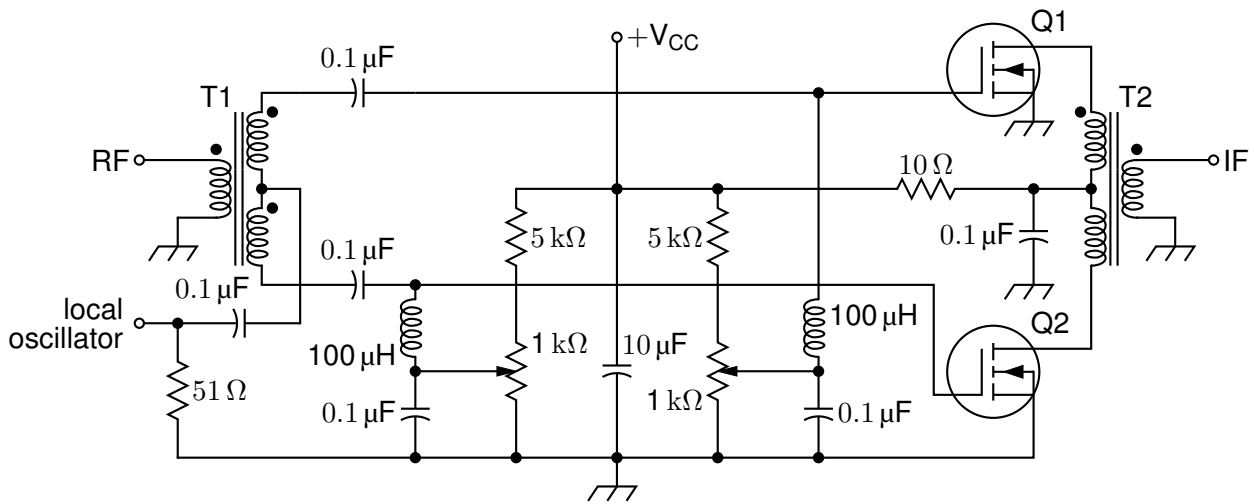


Figure 42: A balanced mixer, using mosfet and a custom transformer [Mixer.m4].

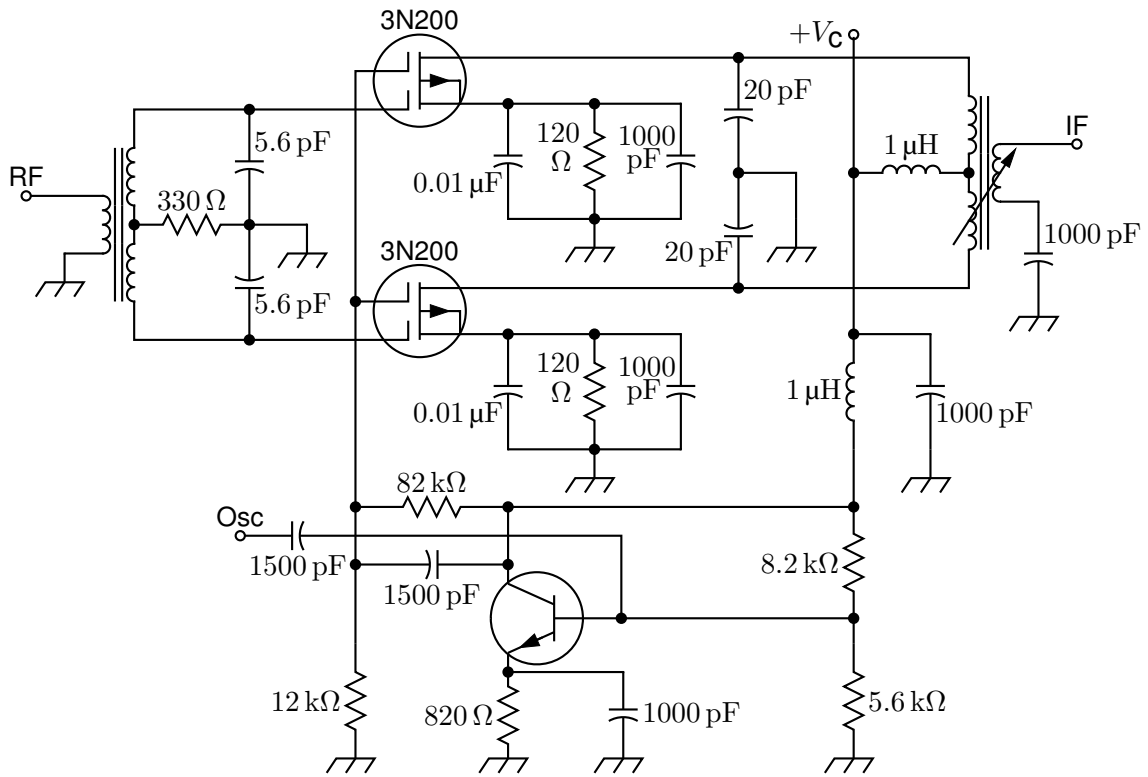


Figure 43: A push-pull mixer, showing FETs with multiple gates [PushPull.m4].

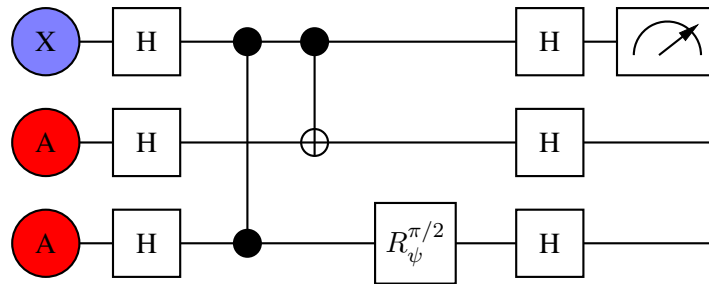


Figure 44: A quantum circuit [Quantum.m4].

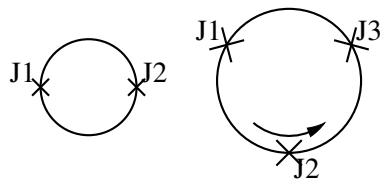


Figure 45: Superconducting quantum interface device (drawing direction down) [SQUID.m4].

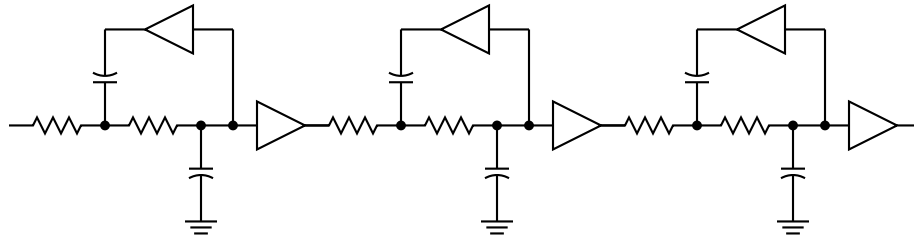


Figure 46: A six-pole filter [Sixpole.m4].

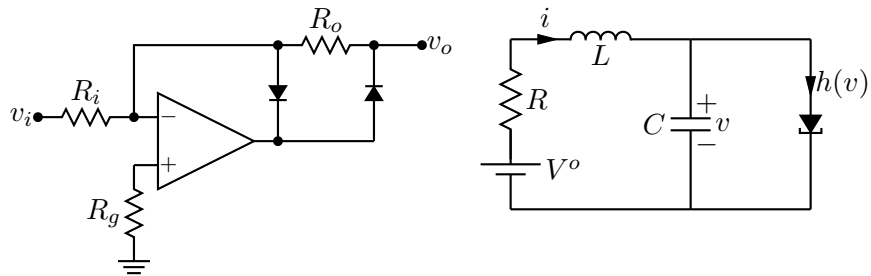


Figure 47: Precision half-wave rectifier and a tunnel diode circuit (illustrating opamp, diode, resistor, ground, and labels) [ex18.m4].

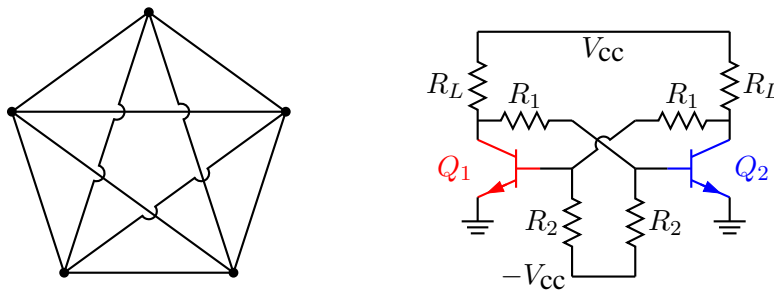


Figure 48: Non-planar graph and bistable circuit (illustrating the crossover macro and colored elements) [ex10.m4].

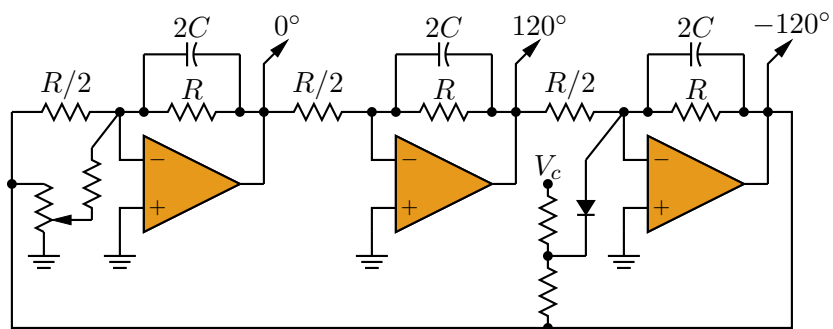


Figure 49: Three-phase oscillator [Three.m4].

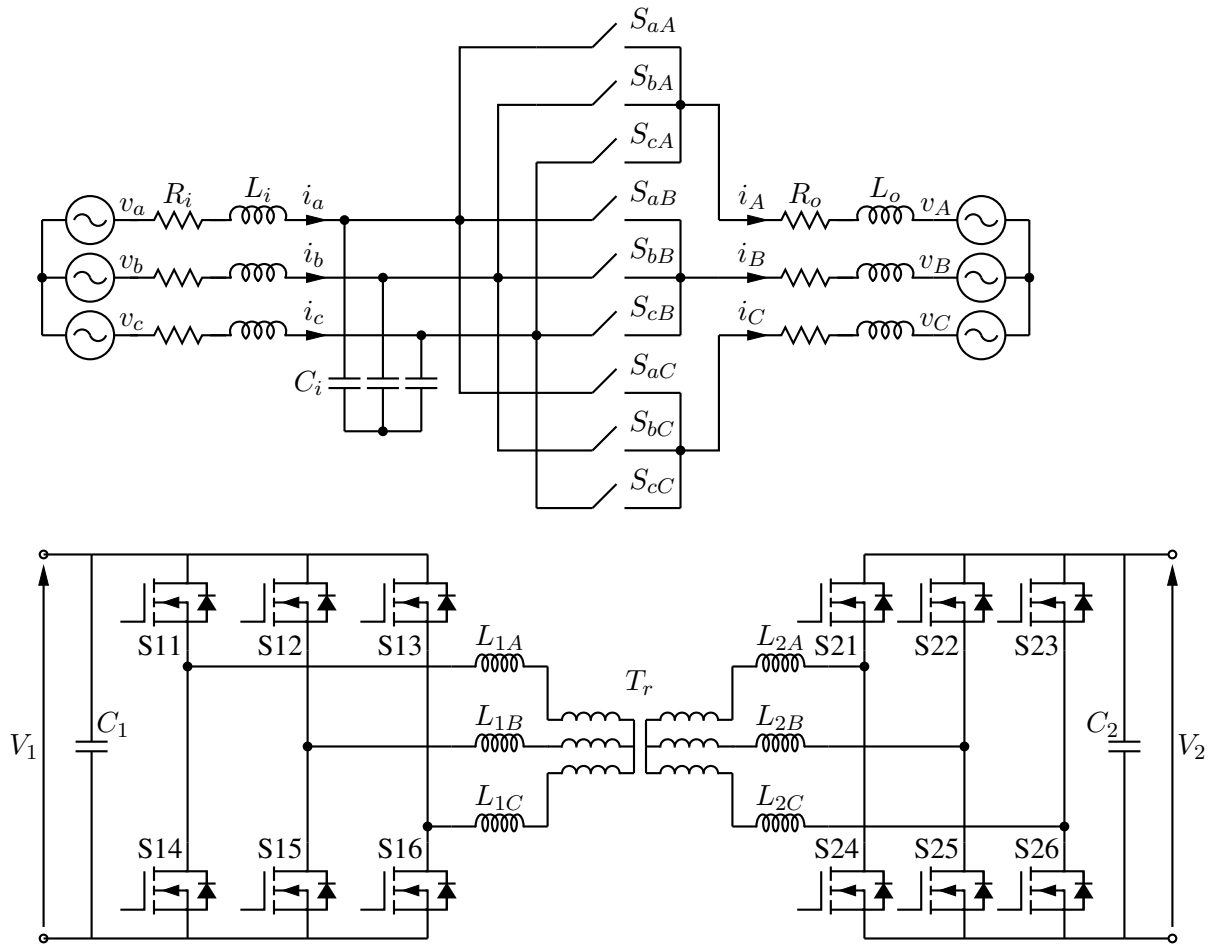


Figure 50: A three-phase switched AC-AC converter and a DC-DC converter [MC.m4].

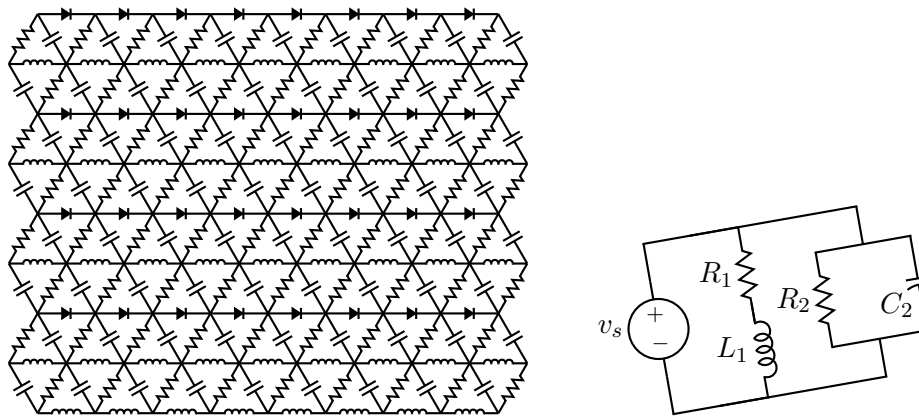


Figure 51: A repetitive network created by Pic looping and a skewed circuit used to test the macro parallel. [ex17.m4].



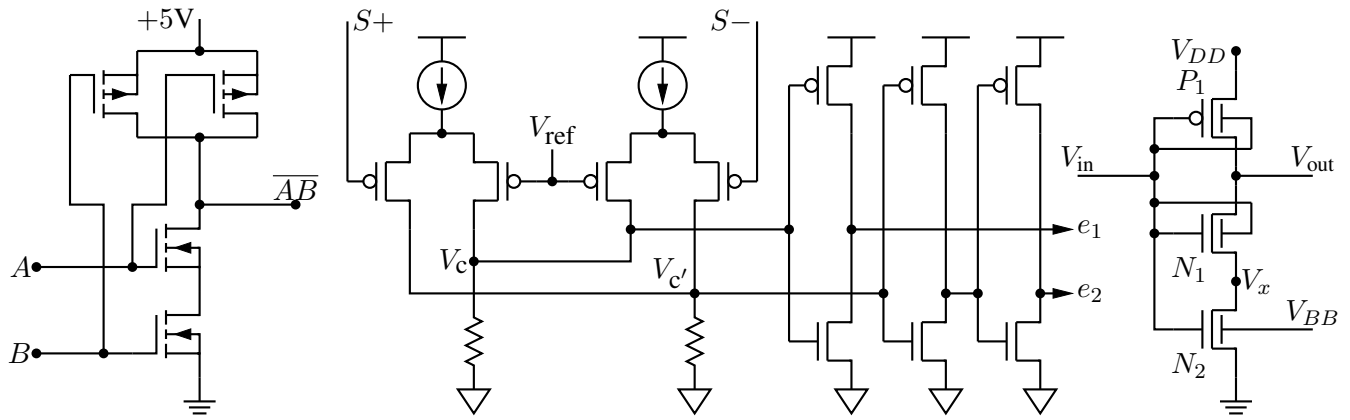


Figure 52: A CMOS NAND gate, a test circuit, and an X MOSFET example [ex12.m4].

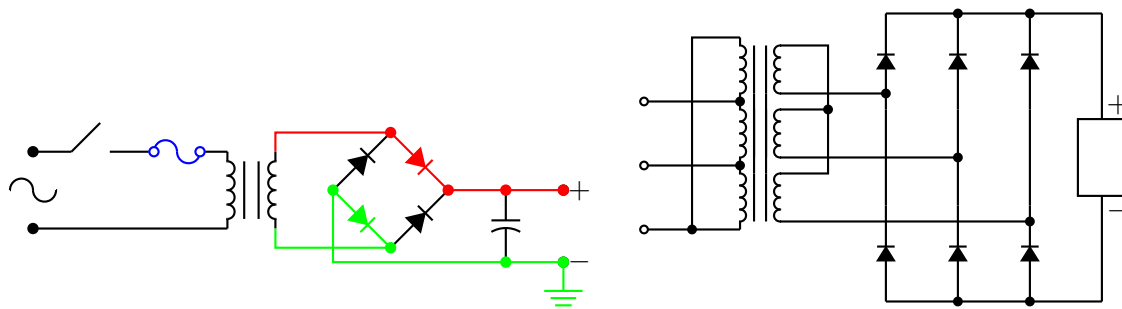


Figure 53: An elementary power supply circuit with colored elements, and a multiple-winding transformer with 3-phase rectifier [pwrsupply.m4].

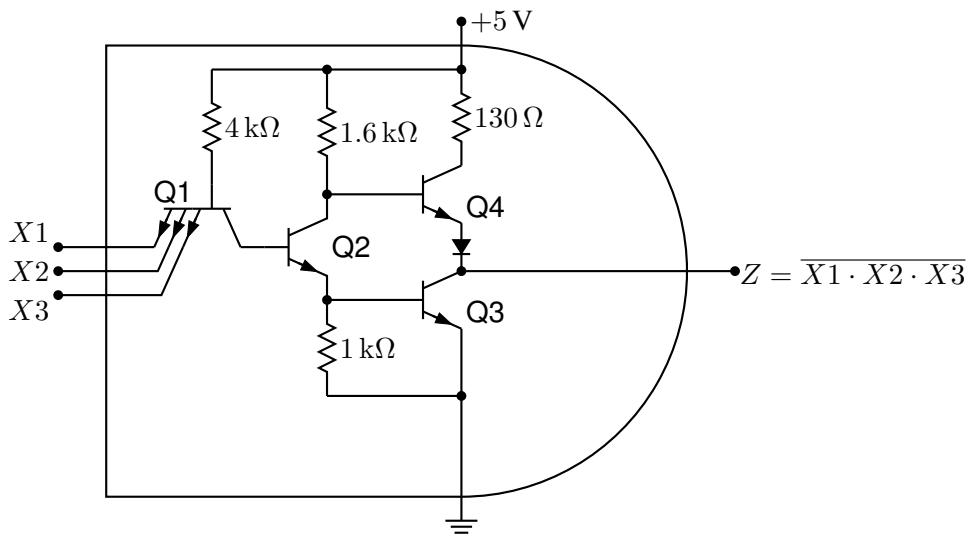


Figure 54: TTL NAND gate illustrating a transistor with multiple emitters [TTLnand.m4].



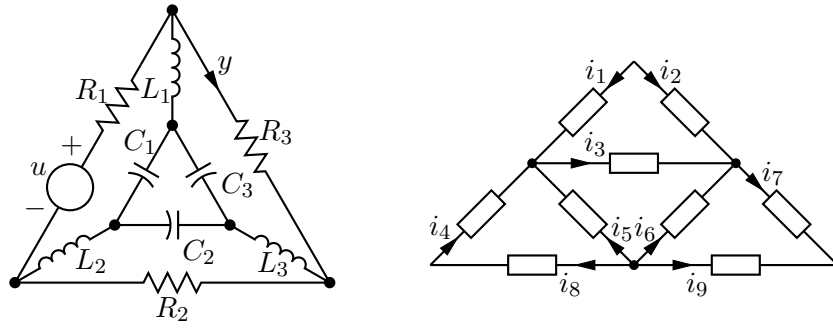


Figure 58: Labels on non-manhattan elements [ex04.m4].

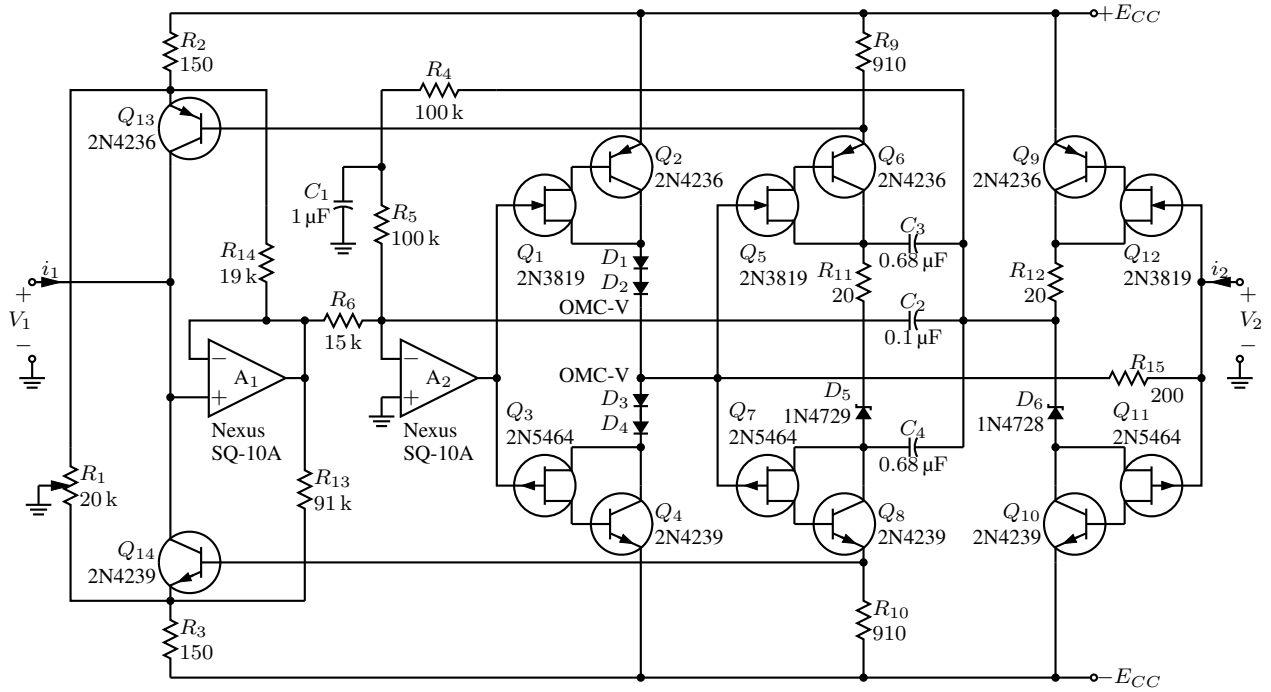


Figure 59: Realization of a controlled source (illustrating stacked element labels) [Csource.m4].

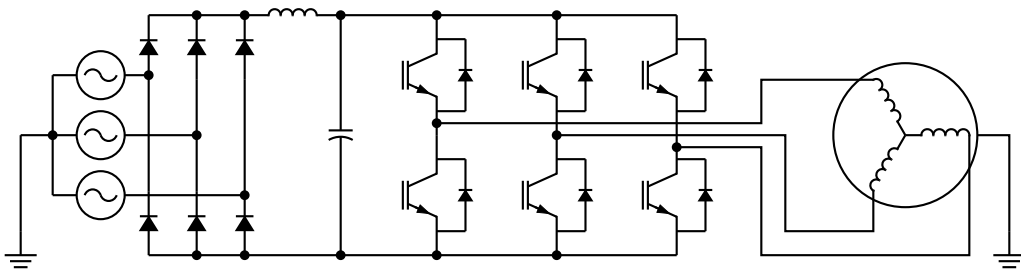


Figure 60: Synchronous machine driven by variable-speed drive and rectifier [Drive.m4].

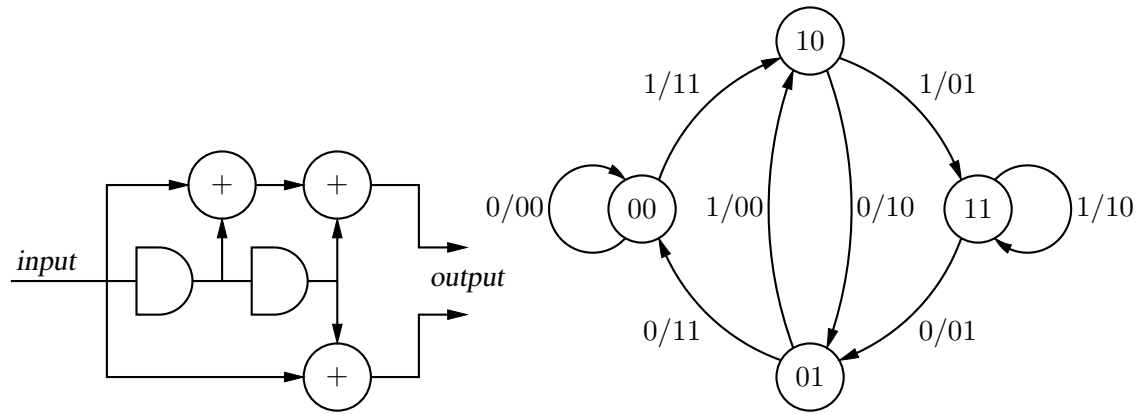


Figure 61: A rate 1/2 binary convolutional coder and its state diagram [ex16.m4].

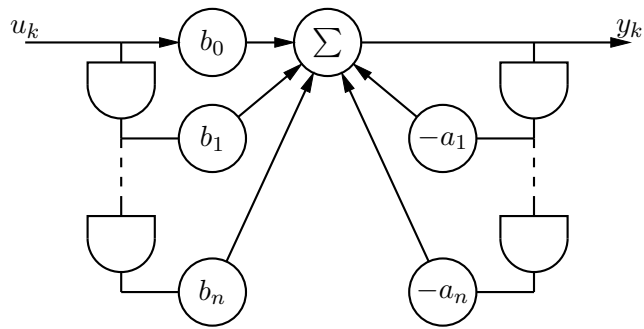


Figure 62: Digital filter [ex03.m4].

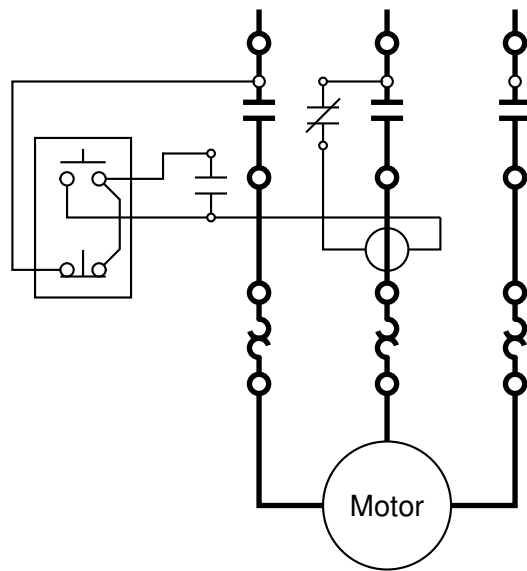


Figure 63: Motor control connections [MotorControl.m4].

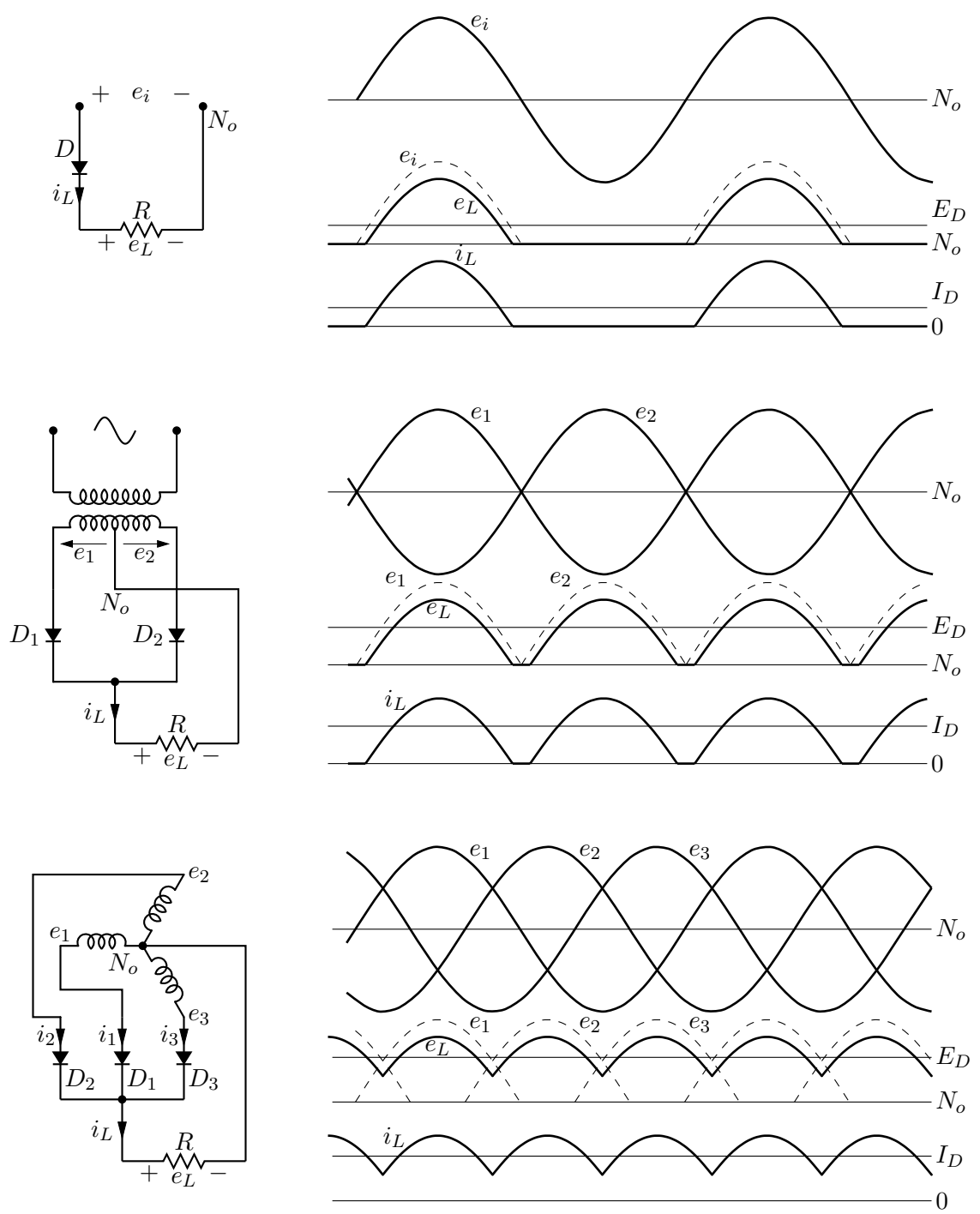


Figure 64: Rectifier circuits and waveforms [Rectifiers.m4].

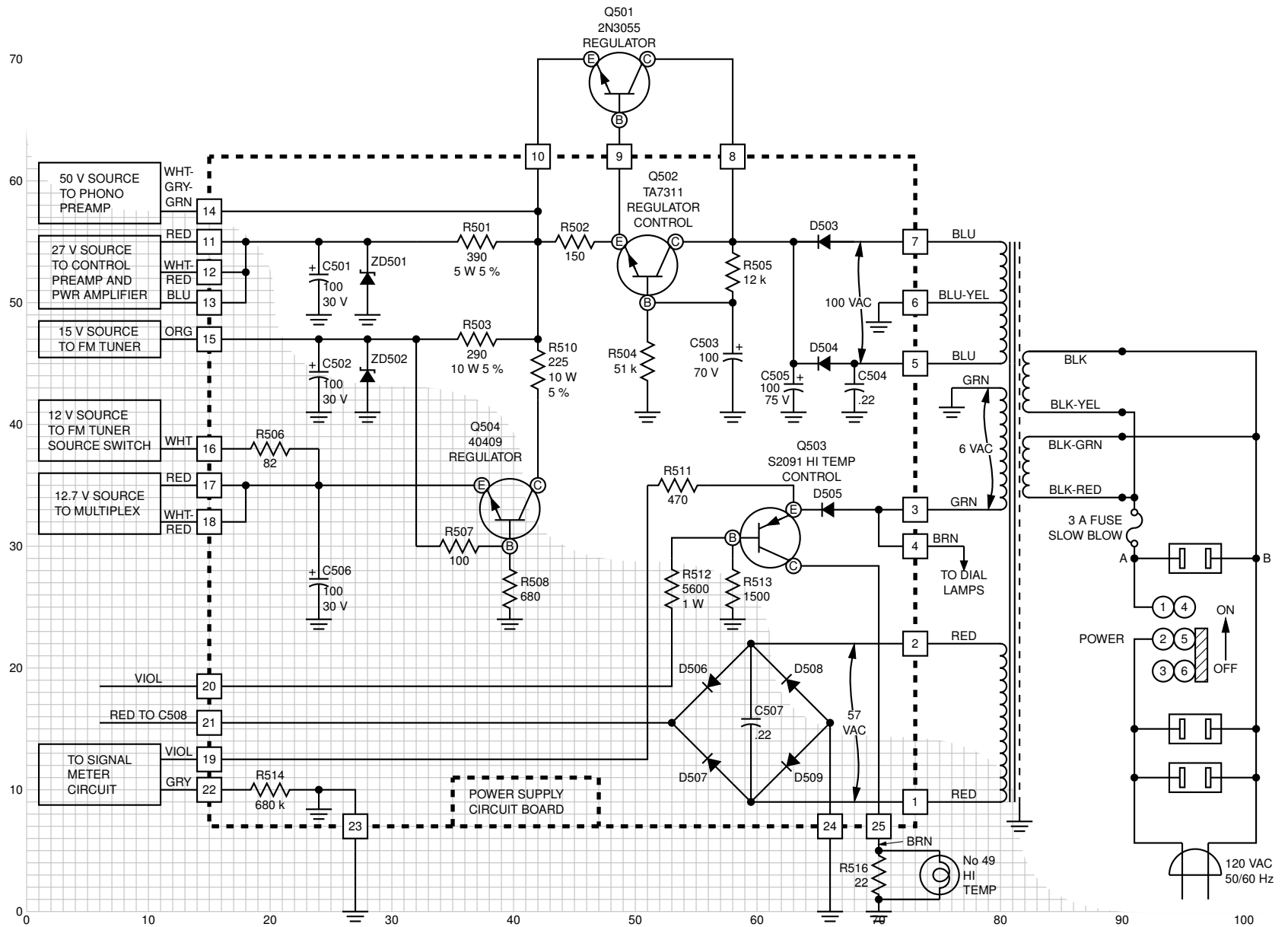


Figure 65: The power supply of a Heathkit AR-15 (Now, *that* was a receiver!) with custom transformer and other elements, drawn on a grid (partially shown) to aid in placement [Heathkit.m4].

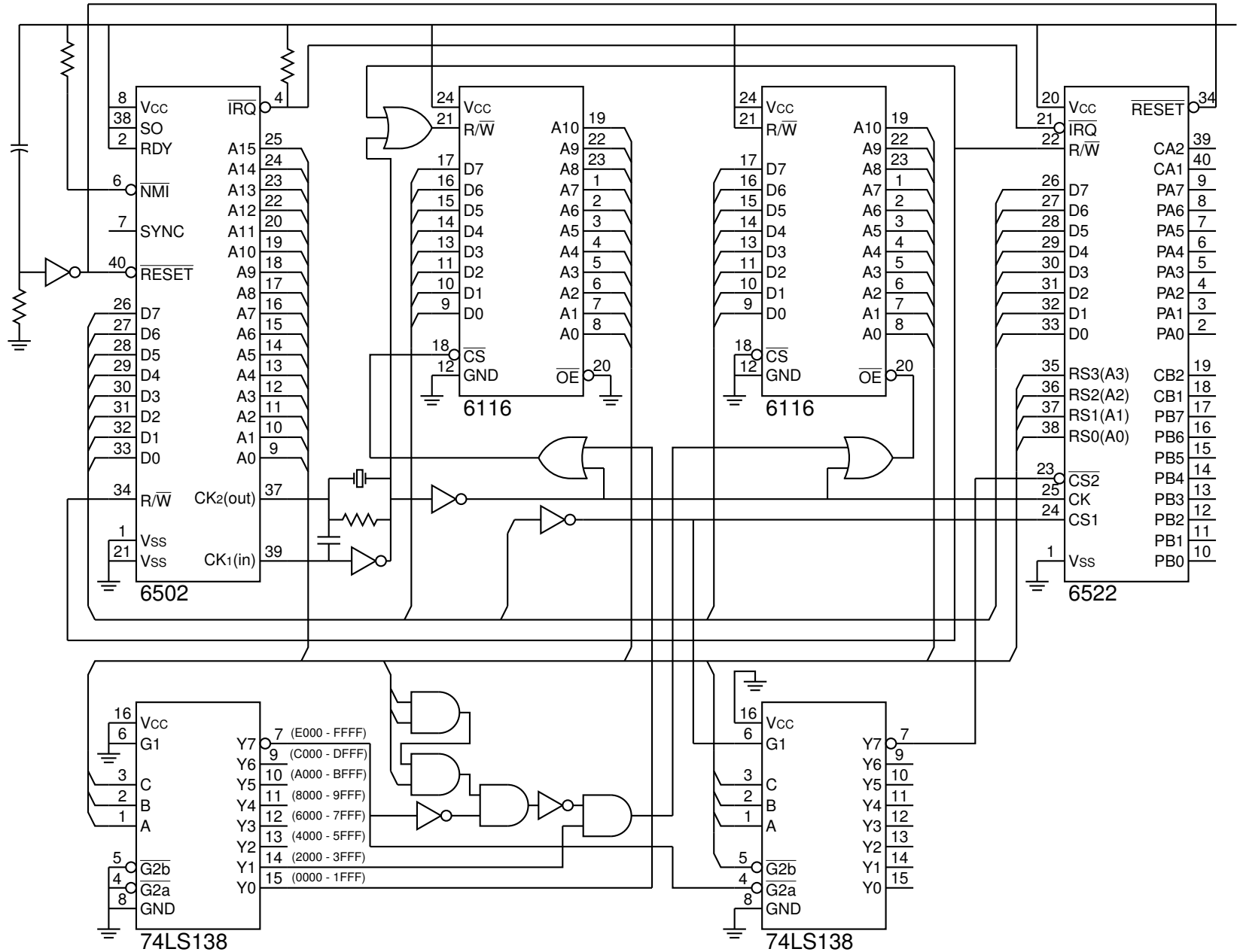


Figure 66: A digital circuit of moderate size, redrawn from M. P. Maclenan and G. M. Burns, "An Approach to Drawing Circuit Diagrams for Text Books," Tugboat (12)1, March 1991, pp. 66-69 [lcct.m4].

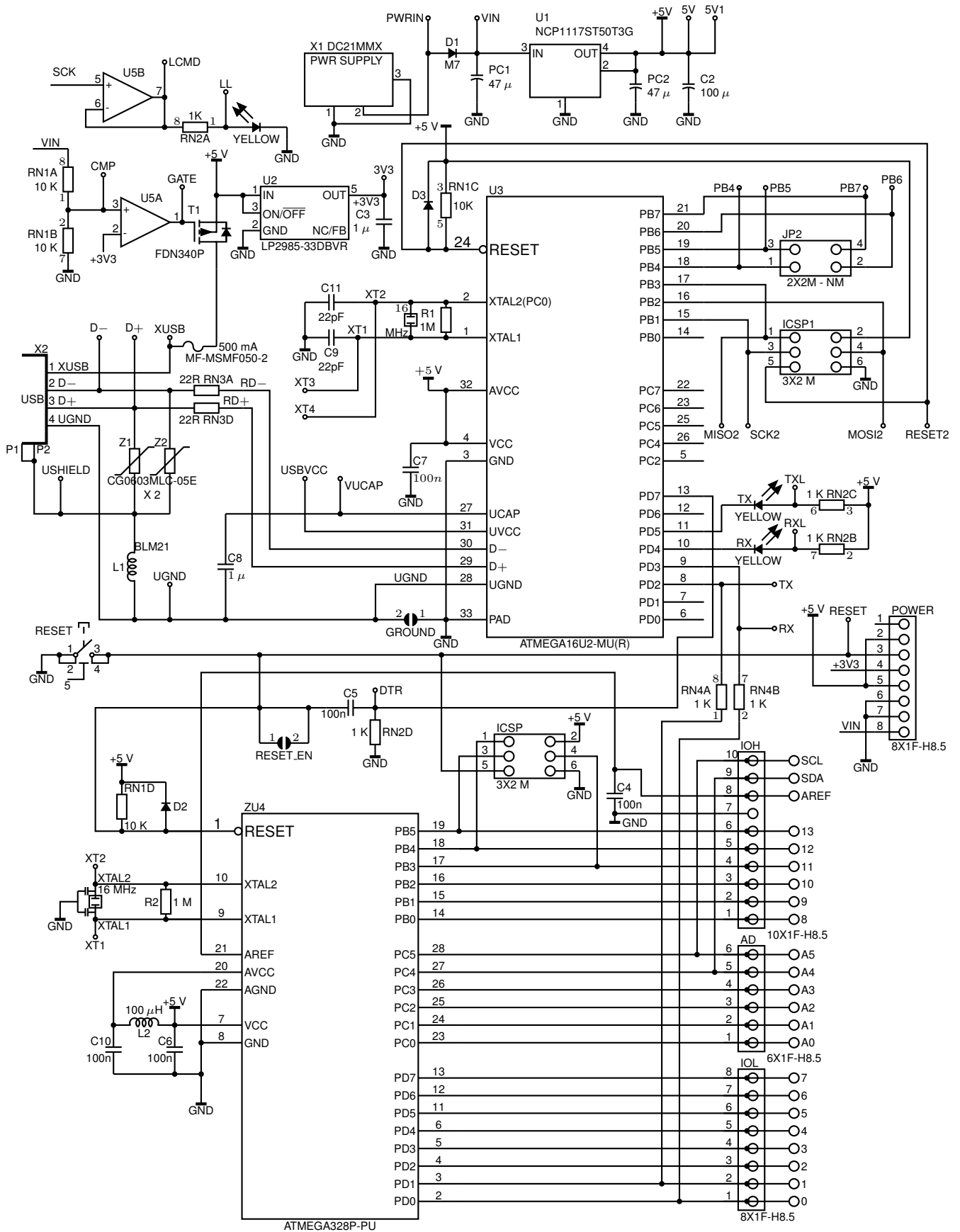


Figure 67: An Arduino UNO circuit adapted and redrawn [ UNO .m4 ].





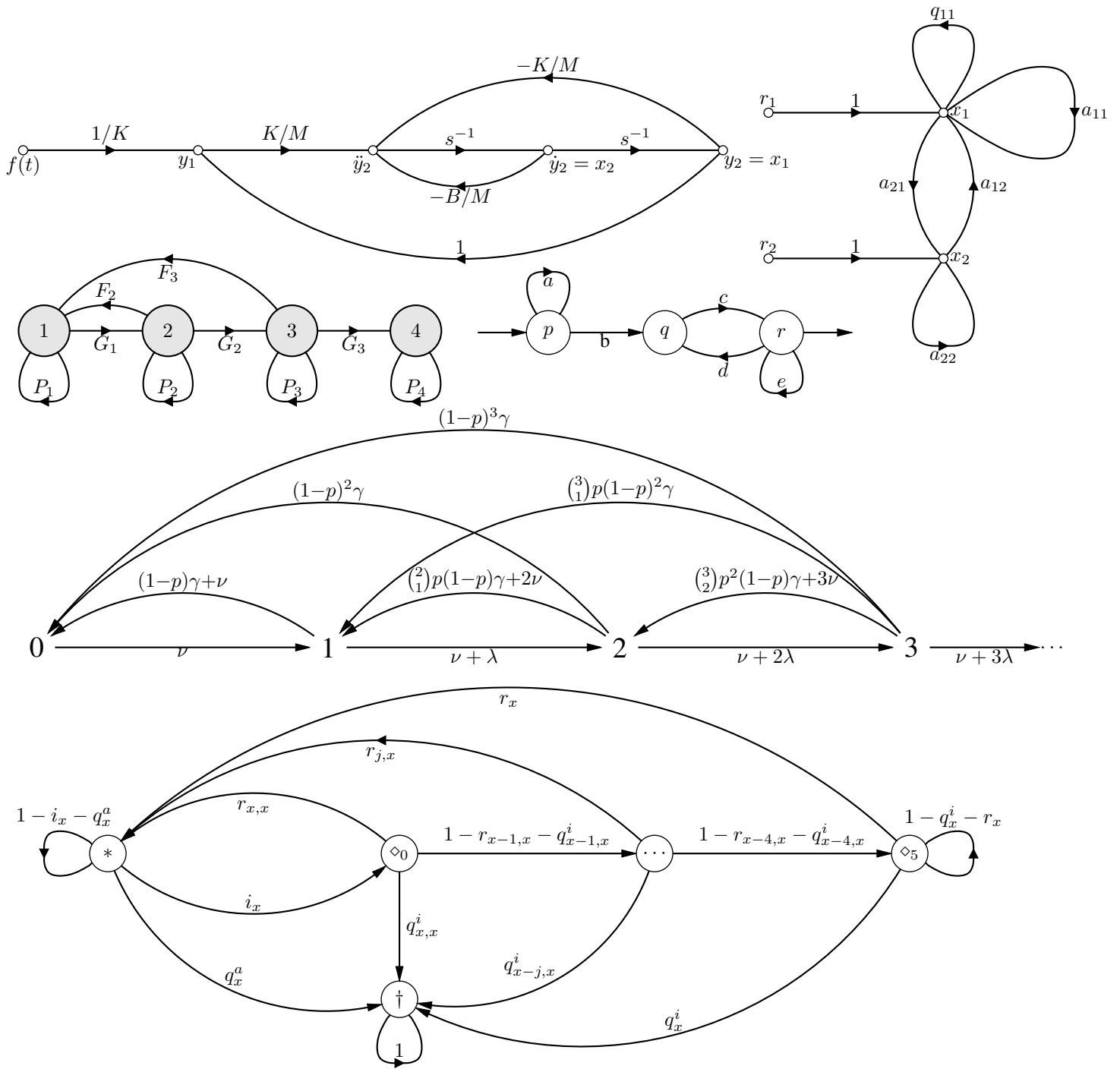


Figure 69: Signal-flow graphs [sfg.m4].

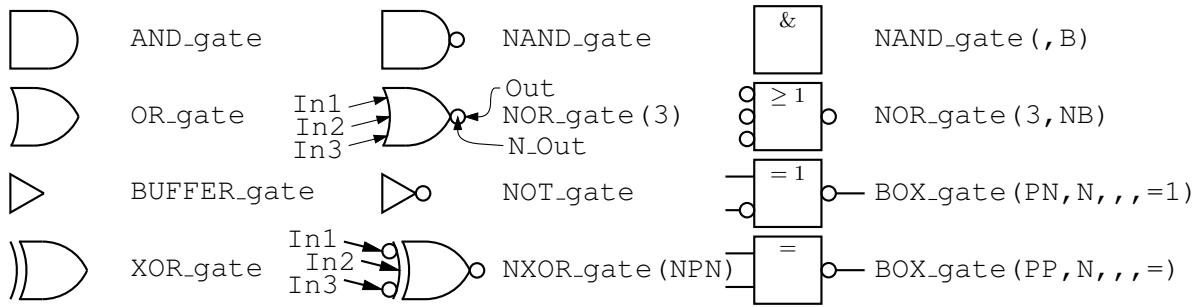


Figure 70: Basic logic gates [Logic.m4].

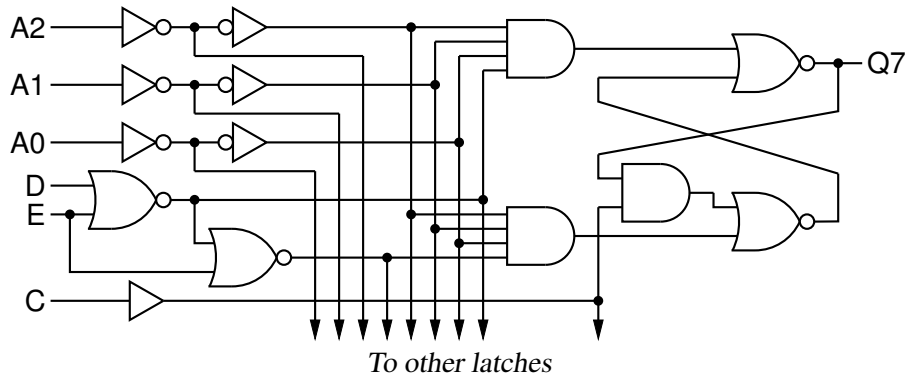


Figure 71: General-purpose latch: a small logic circuit [ex08.m4].

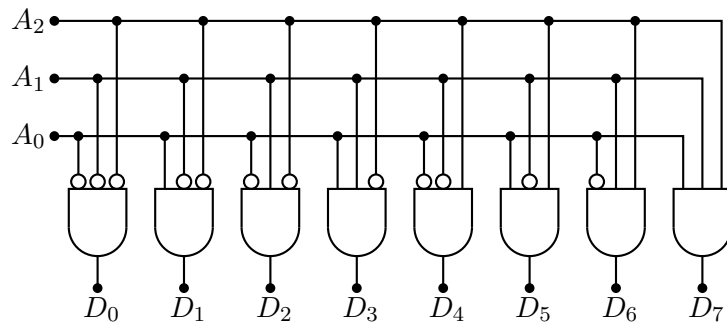


Figure 72: Decoder logic, constructed using the for\_macro [Decoder.m4].

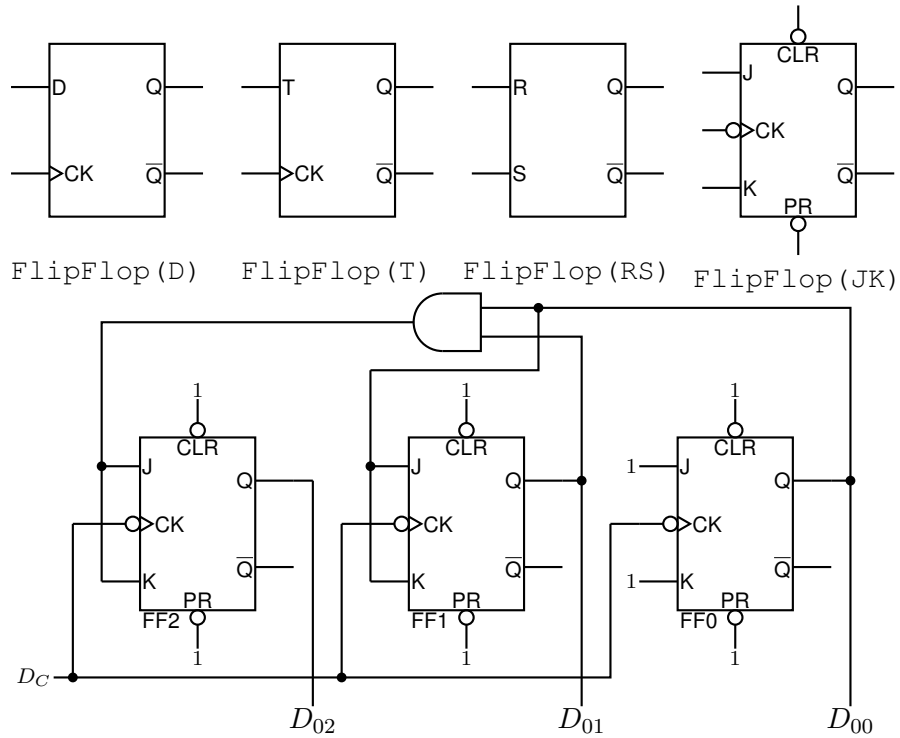


Figure 73: Some flip-flops [ex21.m4].

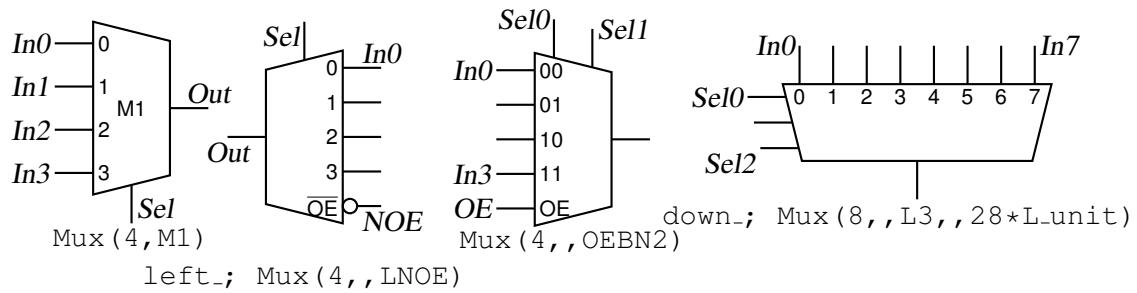


Figure 74: Multiplexer [Multiplexer.m4].

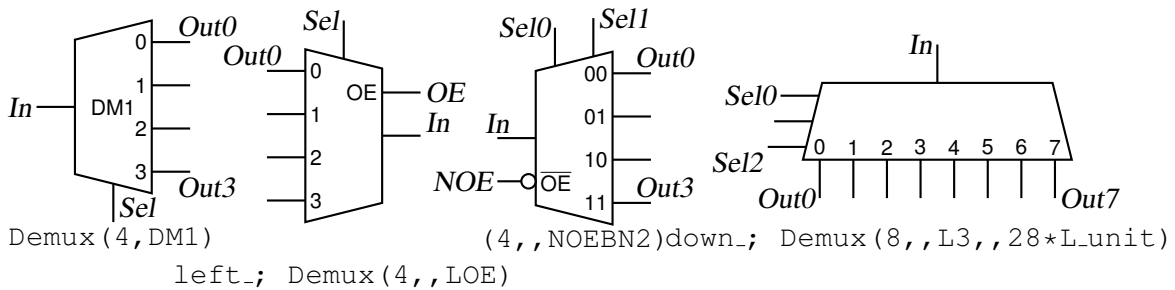


Figure 75: Demultiplexer [Demultiplexer.m4].

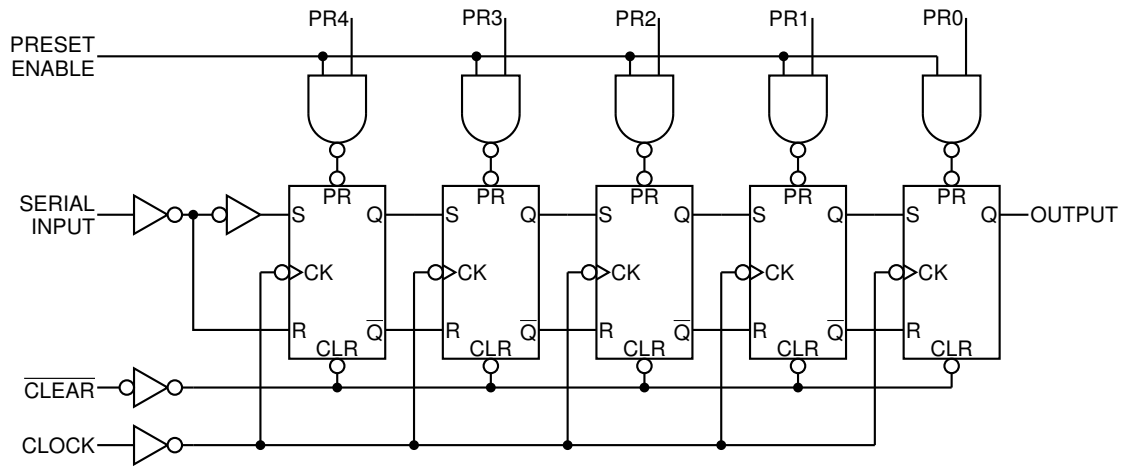


Figure 76: A 5-bit shift register drawn using a custom flip-flop [ShiftR.m4].

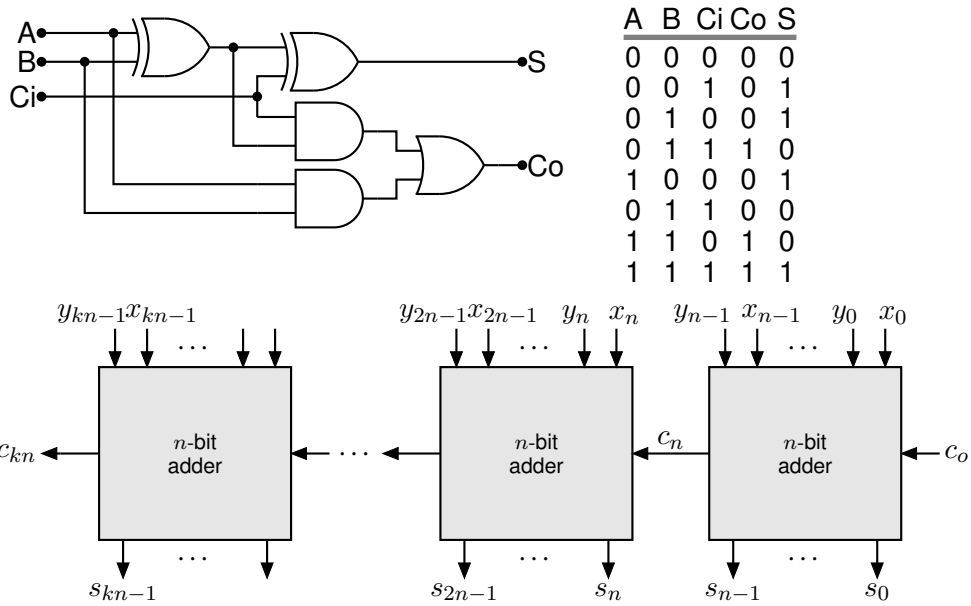
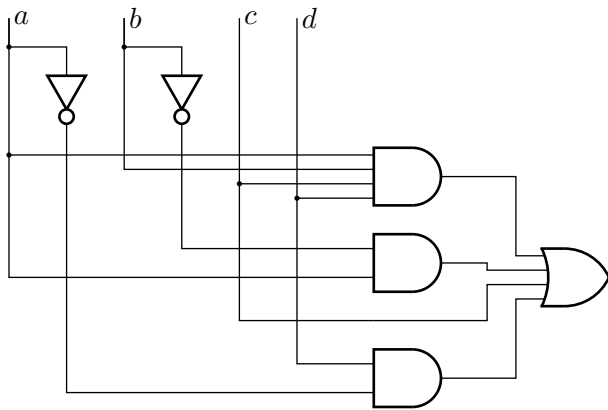
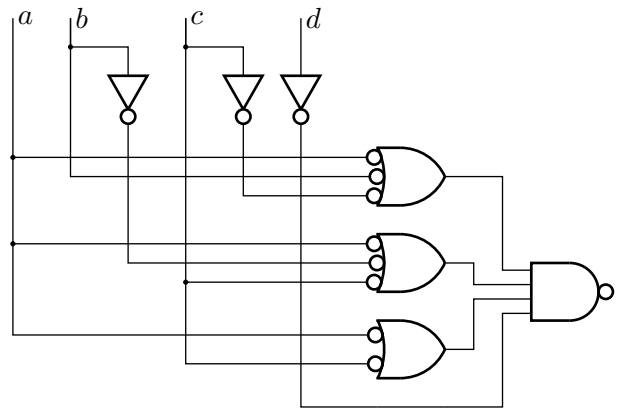


Figure 77: A full adder and a cascade of  $n$ -bit adders [Adder.m4].



CanLogic(AND, OR, abcd, ~ba, c, d~a)



CanLogic(OR, NAND, ab~c, a~bc, ac, ~d)

Figure 78: A way of automatically drawing two-layer logic diagrams [CanLogic.m4].

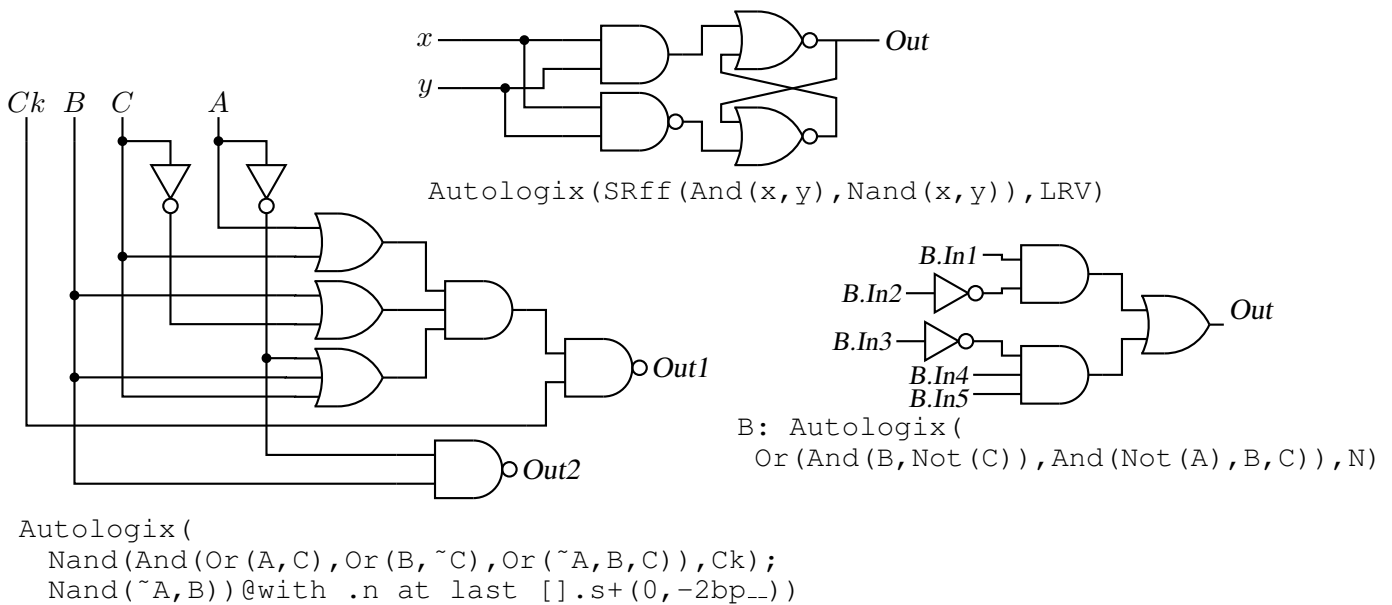
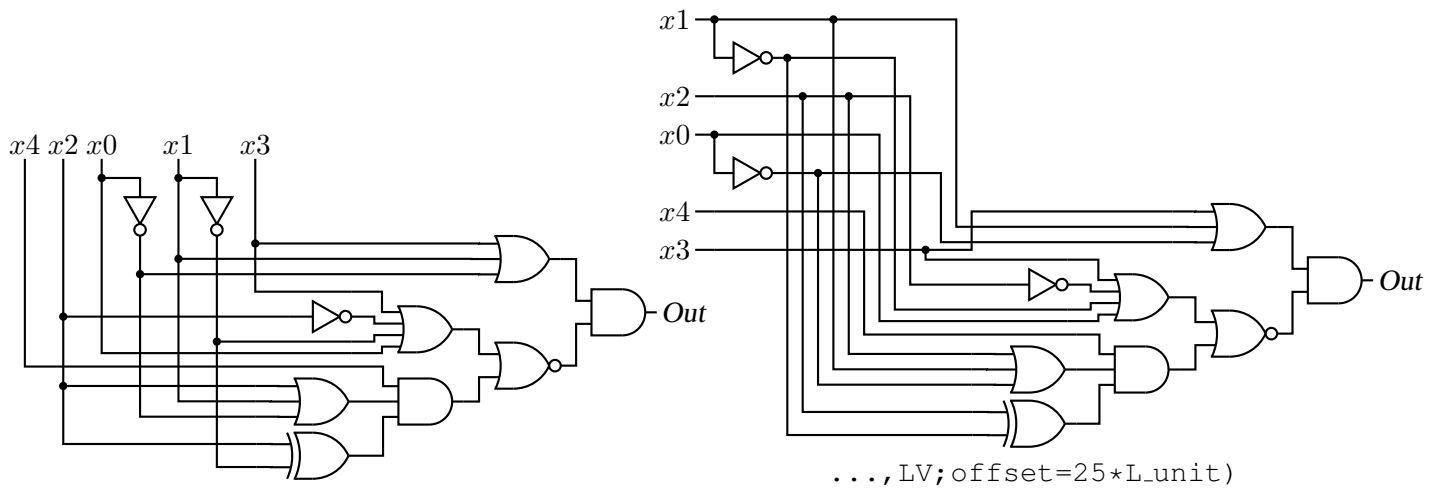


Figure 79: The Autologix (Boolean expression; Boolean expression... , options) macro automatically draws Boolean expressions in function notation. The function tree is drawn, then a row or column of inputs, then the connections. The default result is on the left, a custom element at the top, and a tree of gates only is shown on the right. [Alogix.m4].



```
Autologix (And (Or (x3, x1, ~x0),
  Nor (Or (x3, Not (x2), ~x1, x0), And (x4, Or (x2, x1, ~x0), Xor (x2, ~x1))))))
```

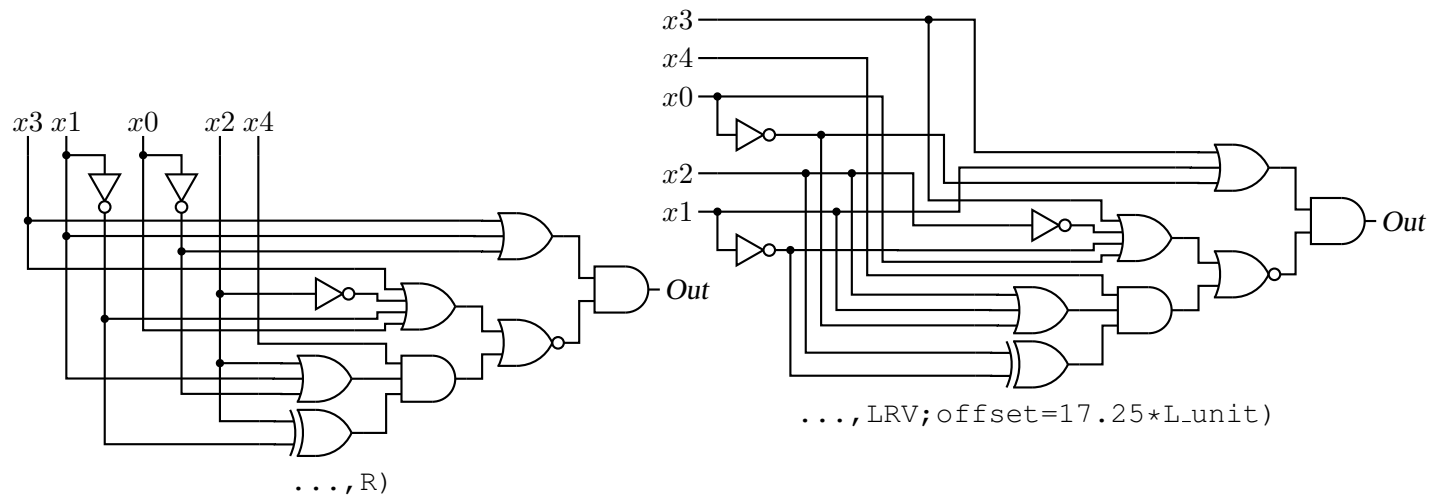


Figure 80: The Autologix macro can draw inputs on the left but the added drawing complexity may require hand tuning with second-argument options: L puts the inputs on the left, R reverses their order, V scans the input arguments in reverse order, and offset=value displaces the array of inputs [ABlogix.m4].

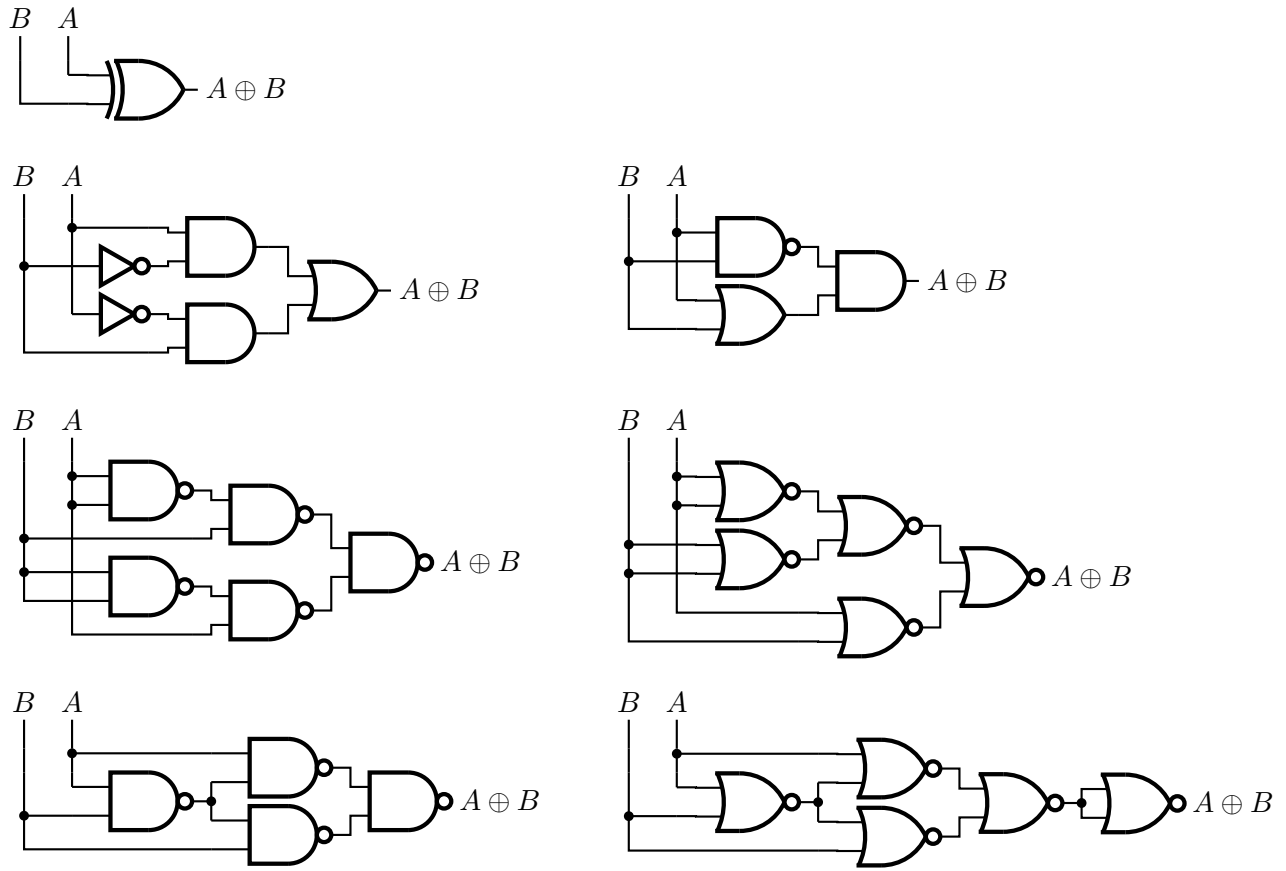


Figure 81: Realizations of the XOR function using Autologix [XOR.m4].

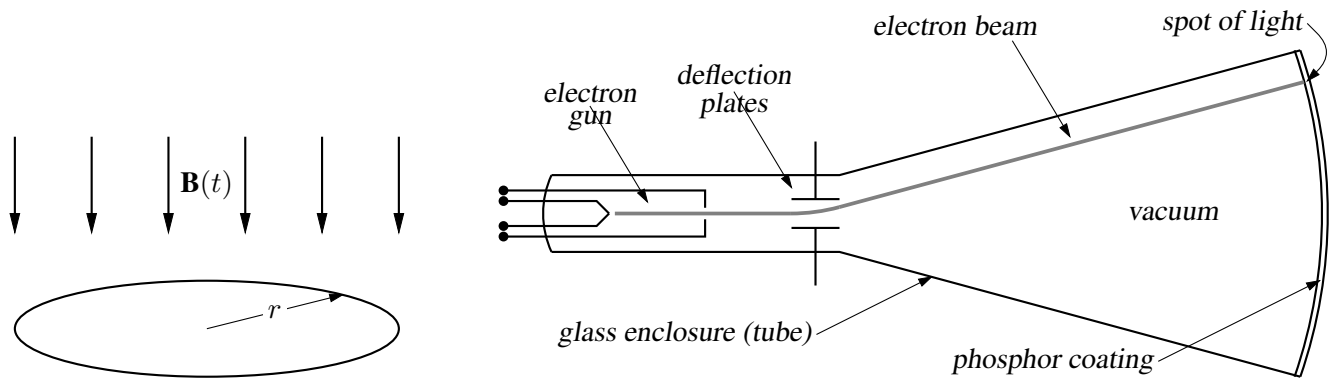


Figure 82: Line diagrams [ex00.m4].



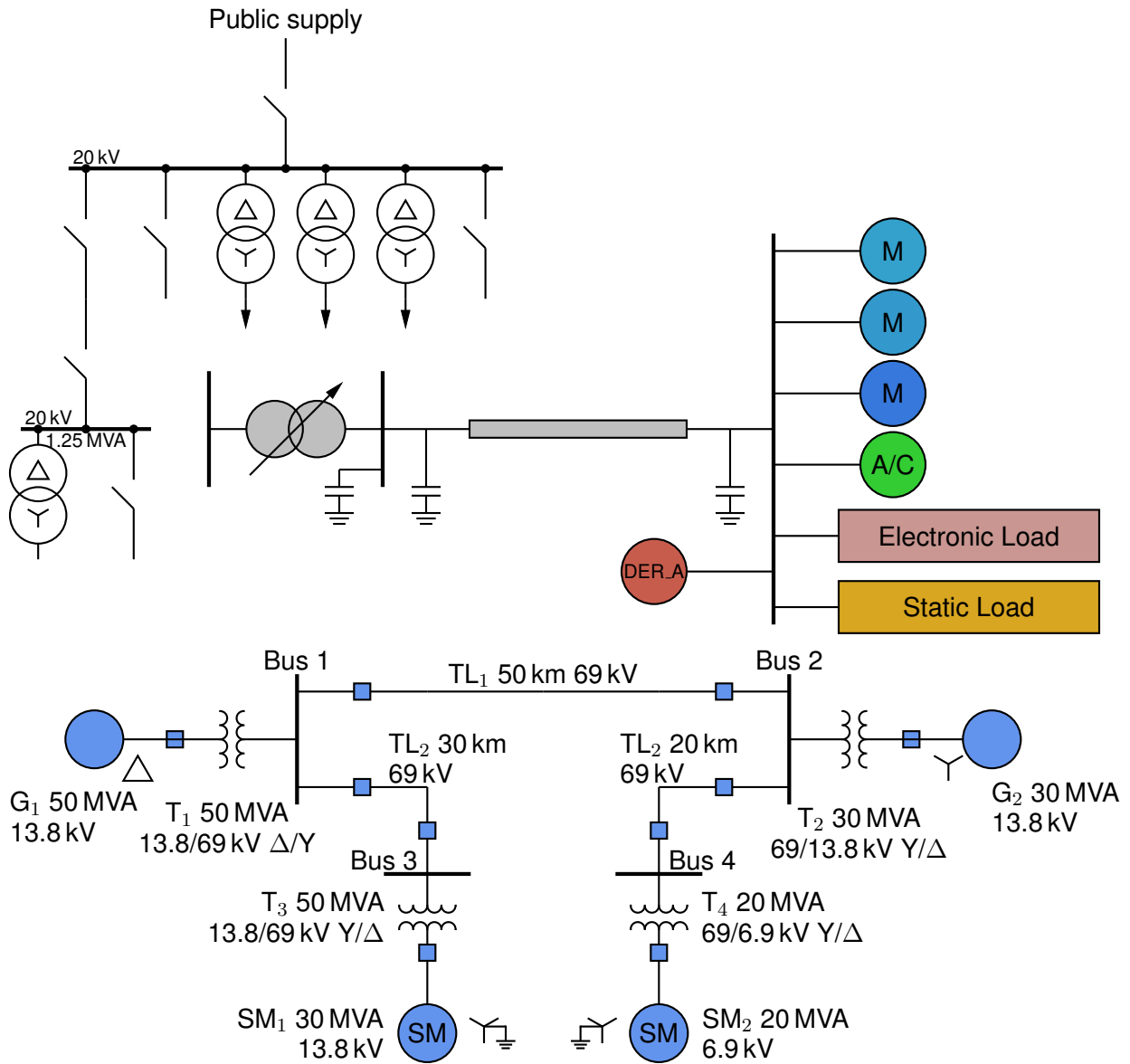


Figure 83: A test of experimental single-line diagram macros [EEP.m4].

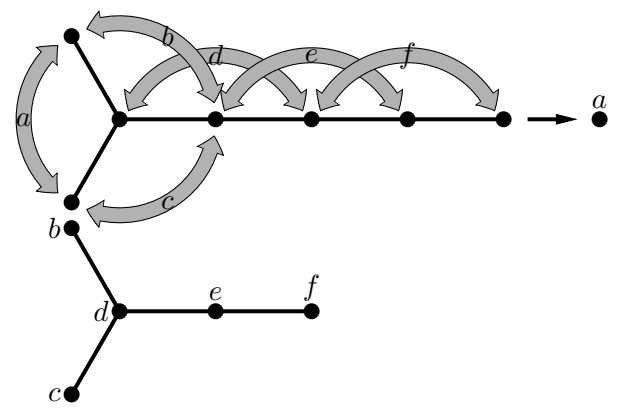
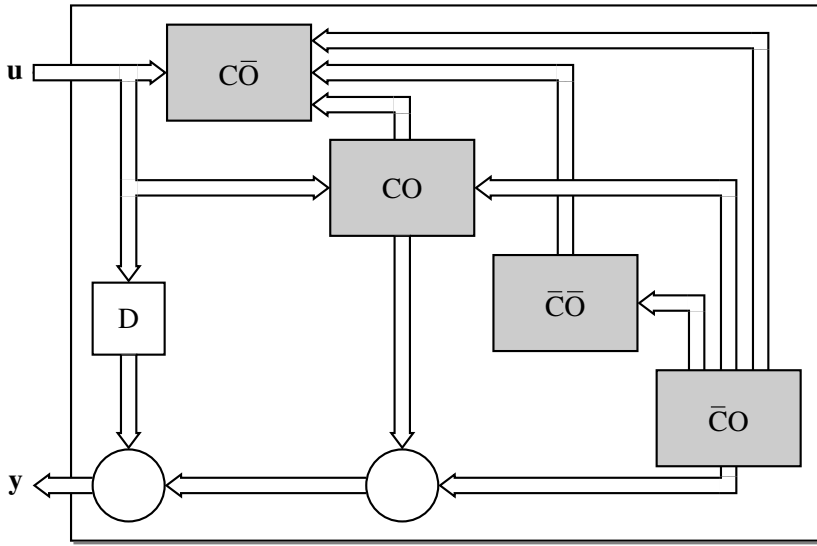


Figure 84: Use of darrow and Darc [ex05.m4].

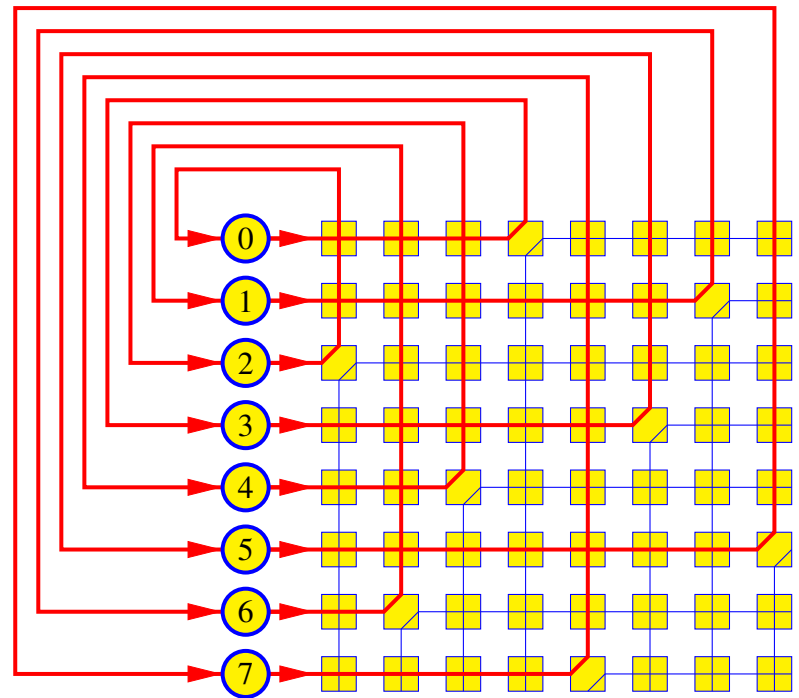
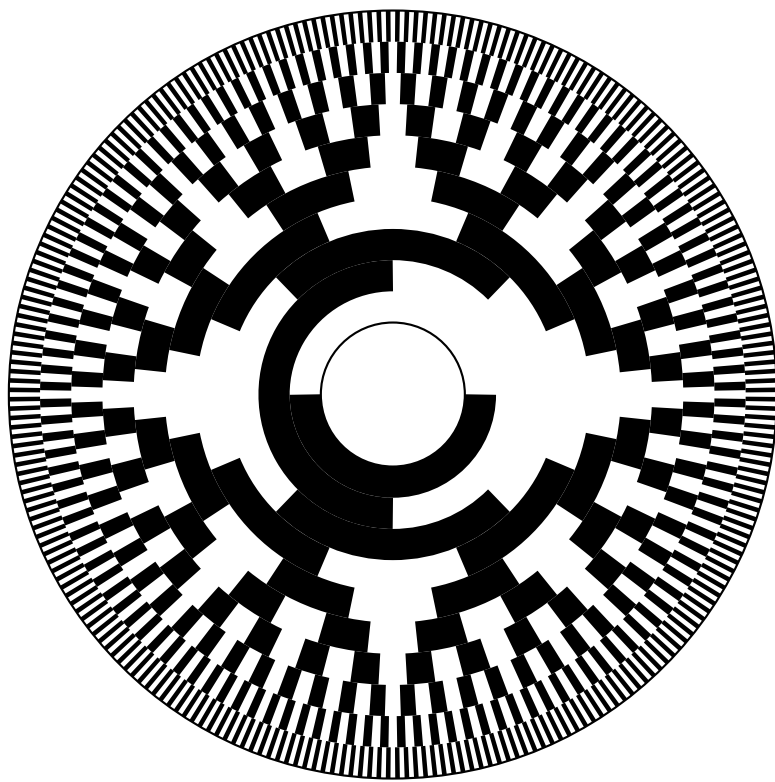
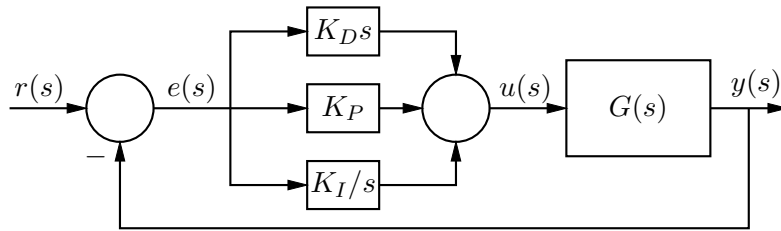
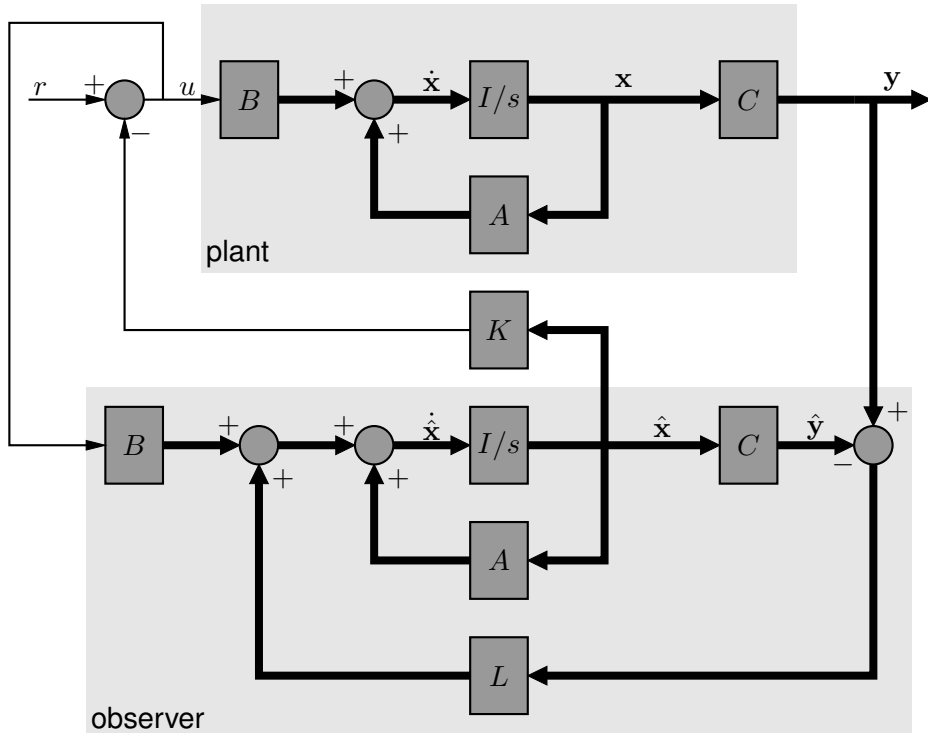


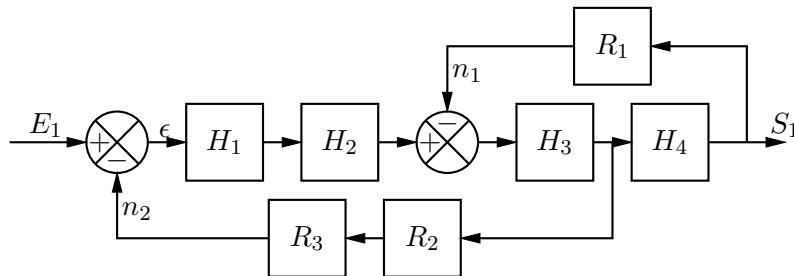
Figure 85: Gray code 10-bit encoder disk pattern and a crossbar switch [GrayCode.m4].



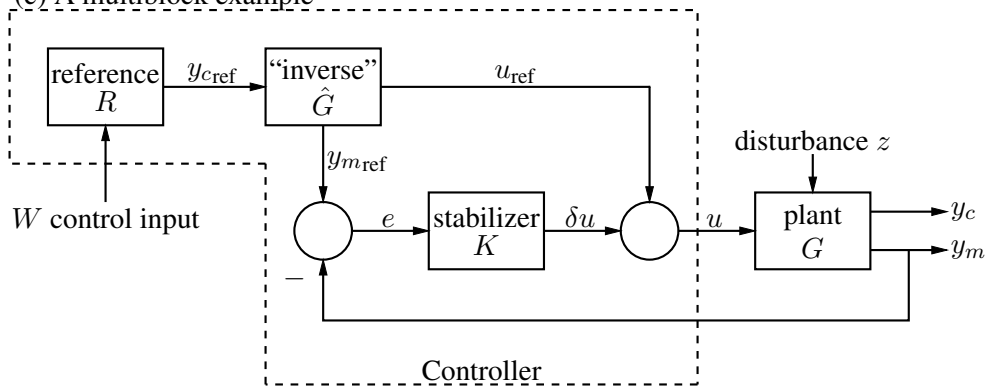
(a) PID control



(b) Single-input plant with feedback from a full-order observer



(c) A multiblock example



(d) Nonlinear feedforward (for performance) and small-signal feedback (for stability)

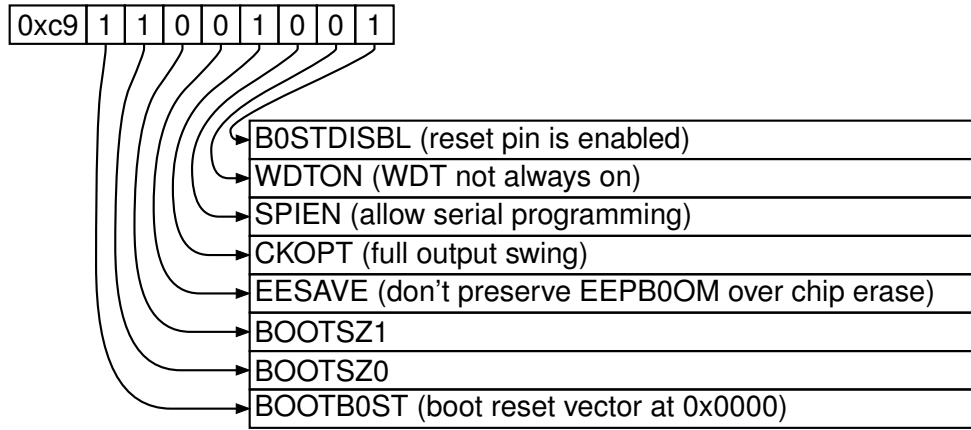


Figure 87: Elementary splines [Byte.m4].

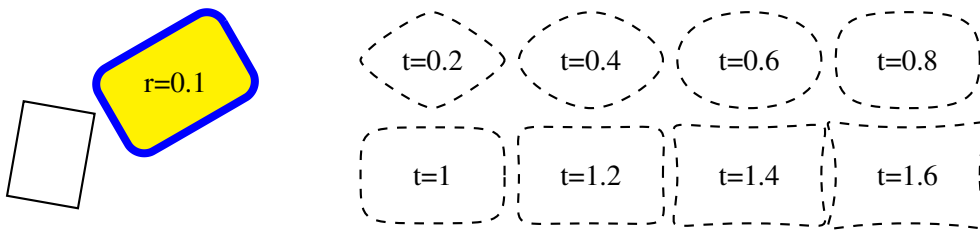


Figure 88: The macro `rotbox(wid,ht,type,[r|t=val])` draws a box in the current direction [Rotbox.m4].

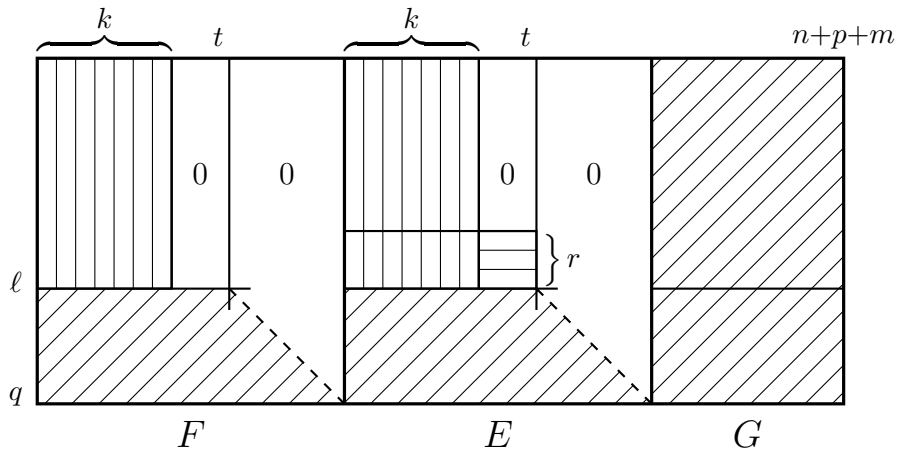


Figure 89: Crosshatching [ex06.m4].

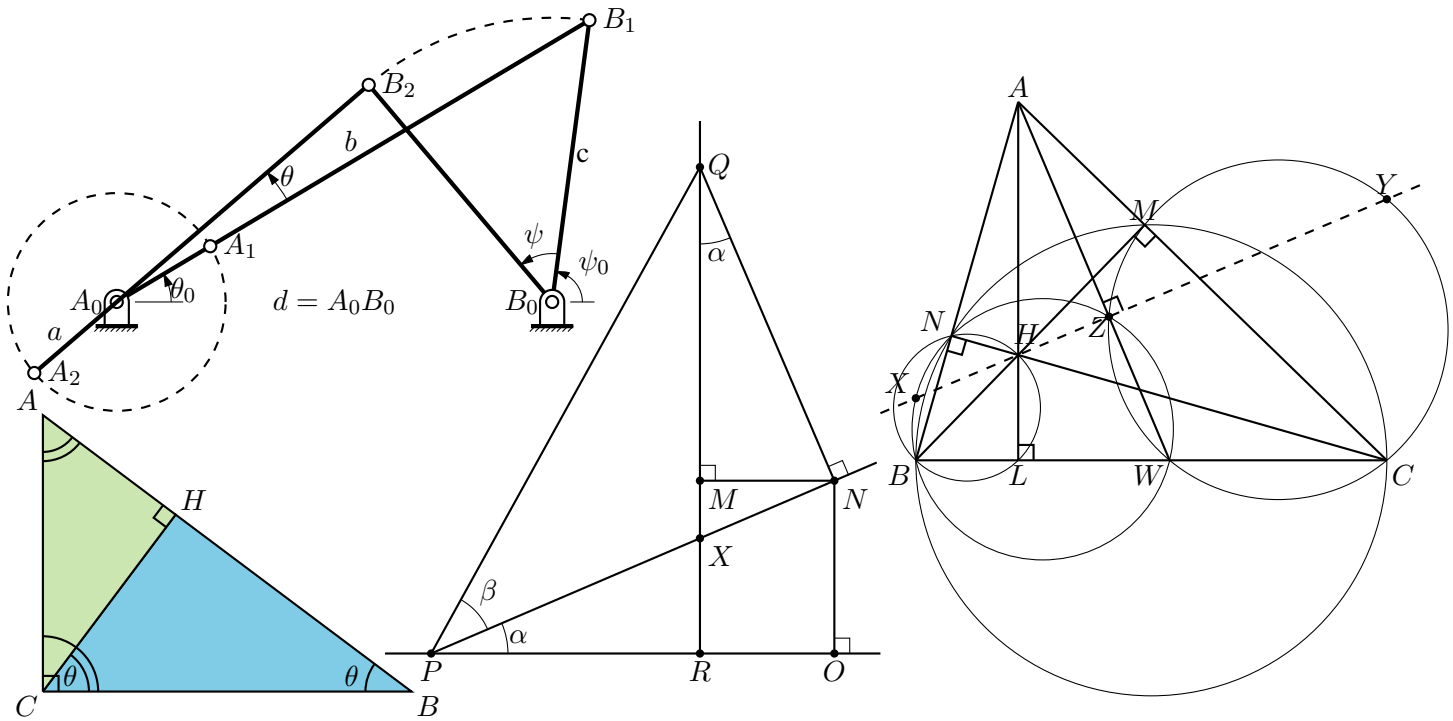


Figure 90: Some geometrical constructions [Geometry.m4].

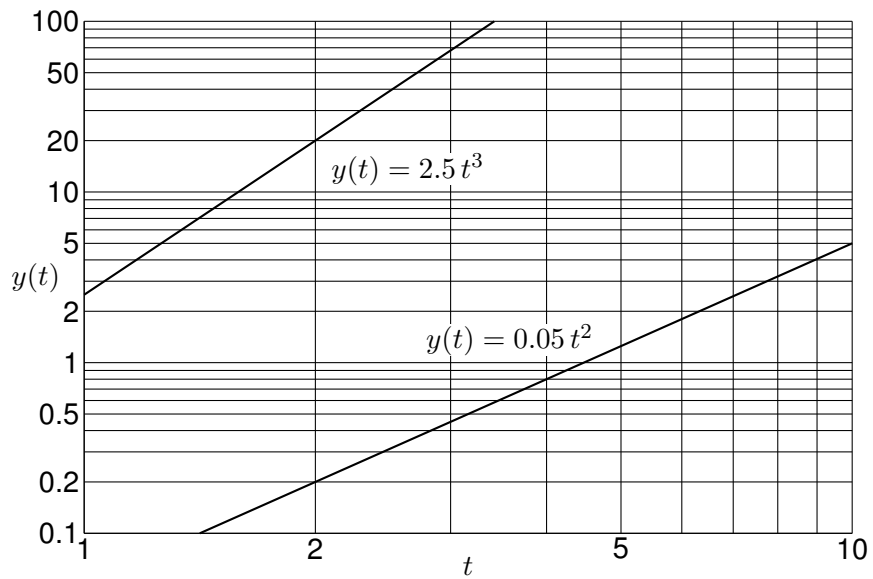


Figure 91: A graph drawn using the pic language [Loglog.m4].

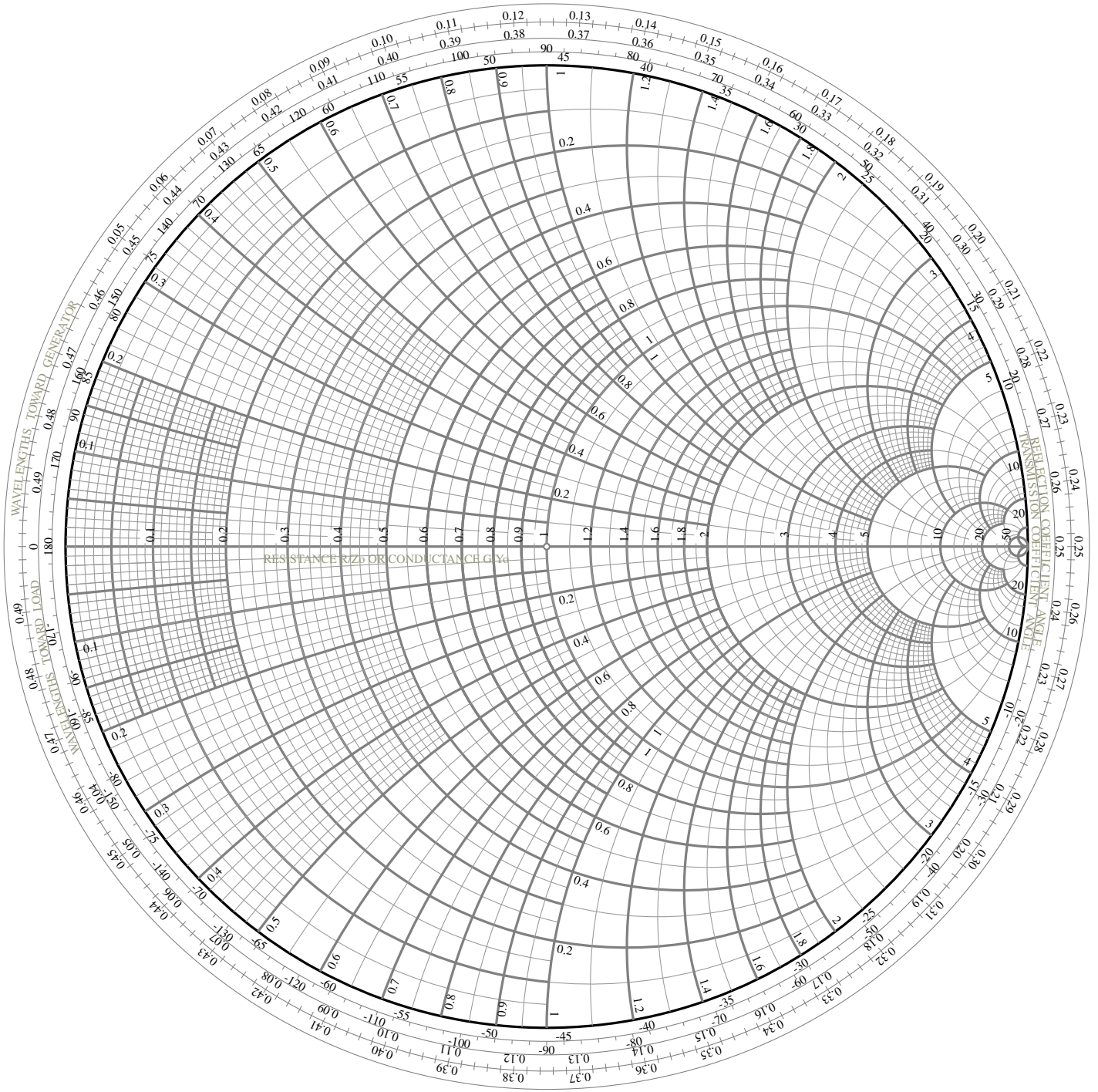
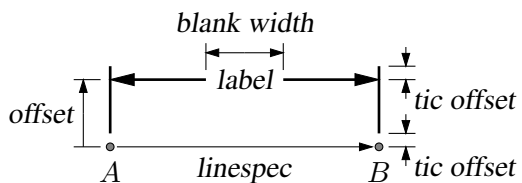
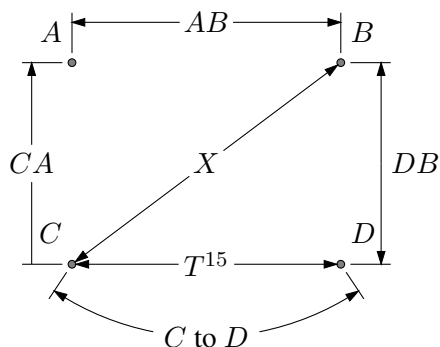
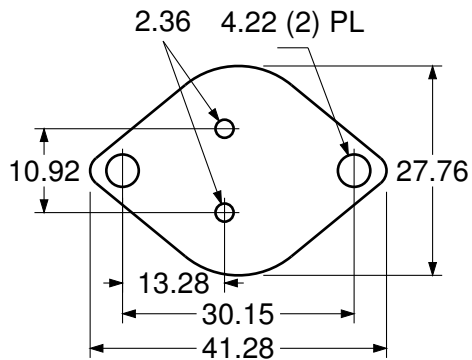


Figure 92: A Smith chart [Smithlchart.m4].



```

dimension_(from A to B,0.3,$AB$,20bp_)
dimension_(from C to B,, $X$,16bp_)
dimension_(from C to A,0.3,$CA$,14bp_,-,->)
dimension_(from D to B,-0.3,"$DB$" ljust)
dimension_(from C to D,, s_box($T^{%g}$,15),W)
arcdimension_(from C to D with .c at \
0.5 between A and B,12bp_-,s_box($C$ to $D$),W)

```

```
dimension_(from A to B,0.5,\sl label,29bp_-,0.1)
```

Figure 93: Illustrating the macro `dimension_`(*linespec*, *offset*, *label*, *D|H|W|blank width*, *tic offset*,*<-|->*). A negative second argument implies an offset to the right of the *linespec* direction. A *label* starting with `"` or `sprintf` is copied literally. If *label* is an `s_box`(...) then setting argument 4 to H, W, or D tailors the blank width to the `s_box` height, width, or diagonal respectively; i.e., W is equivalent to `s_wd+textoffset*2`. The macro `arcdimension_` is similar but the first argument specifies the arc to be dimensioned and the second argument is the outward radial offset of the dimension arrow arc. [ex09.m4].

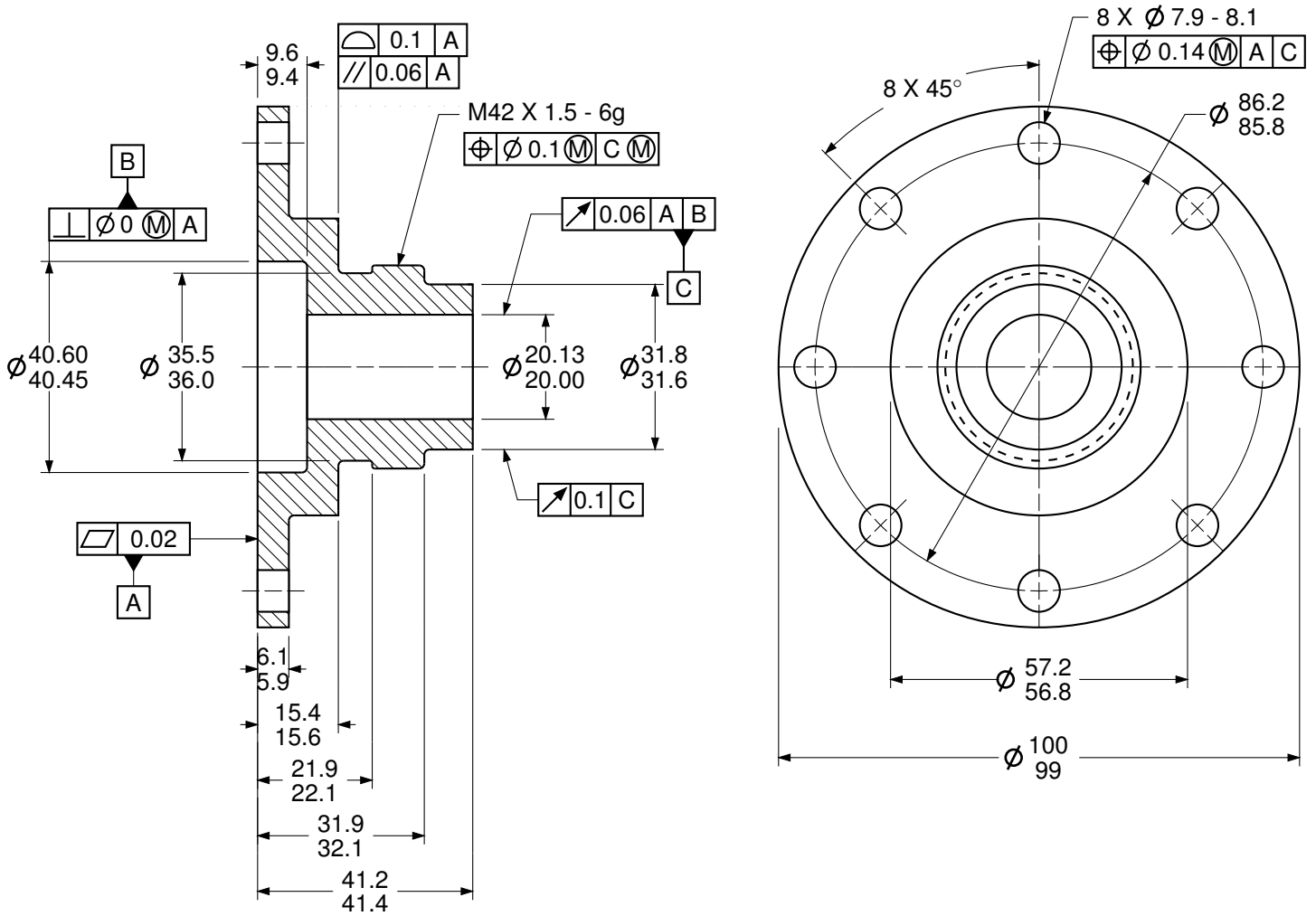


Figure 94: Dimensioning with tolerances [Plate.m4].



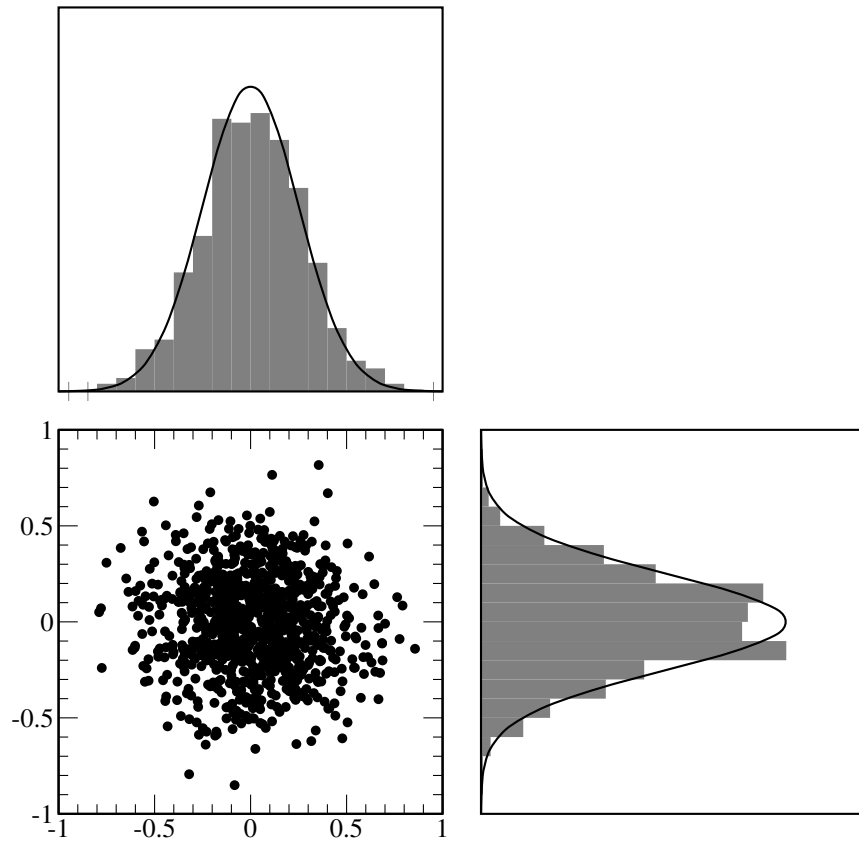


Figure 95: Testing random number generation using `dpic` macro `randn (array name, n, mean, std dev)` which calls `pic` built-in `rand ()` [`random.m4`].

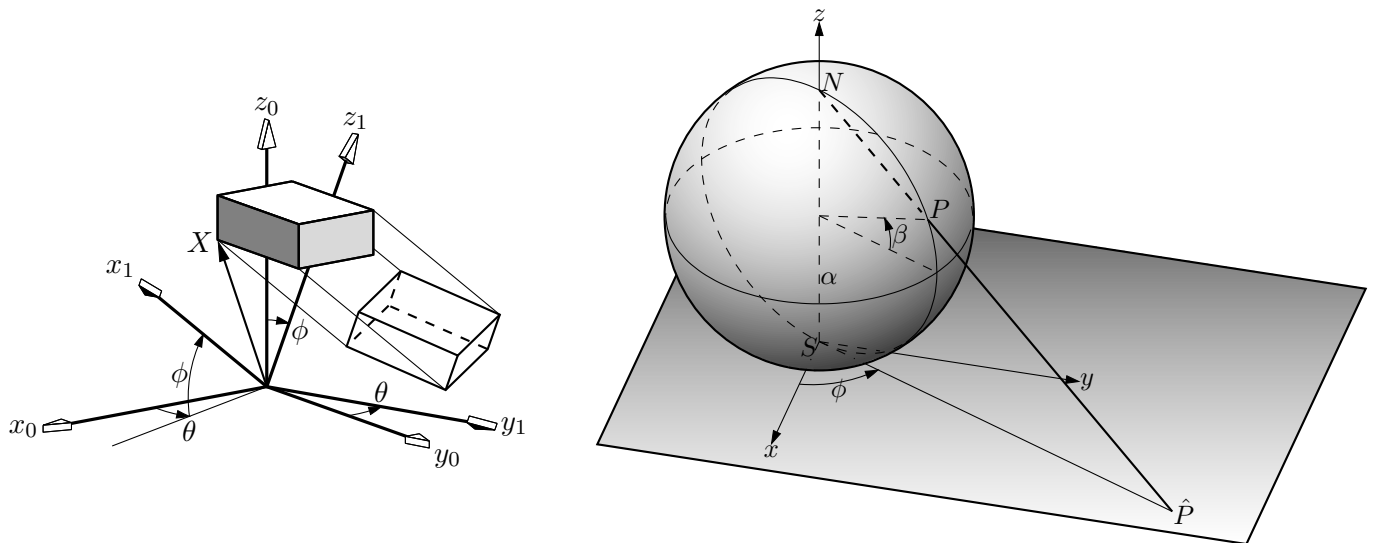


Figure 96: Test of `project` and other `lib3D` macros, showing the projection of a solid onto the  $y_1, z_1$  plane by sighting along the  $x_1$  axis. [`exp.m4`].

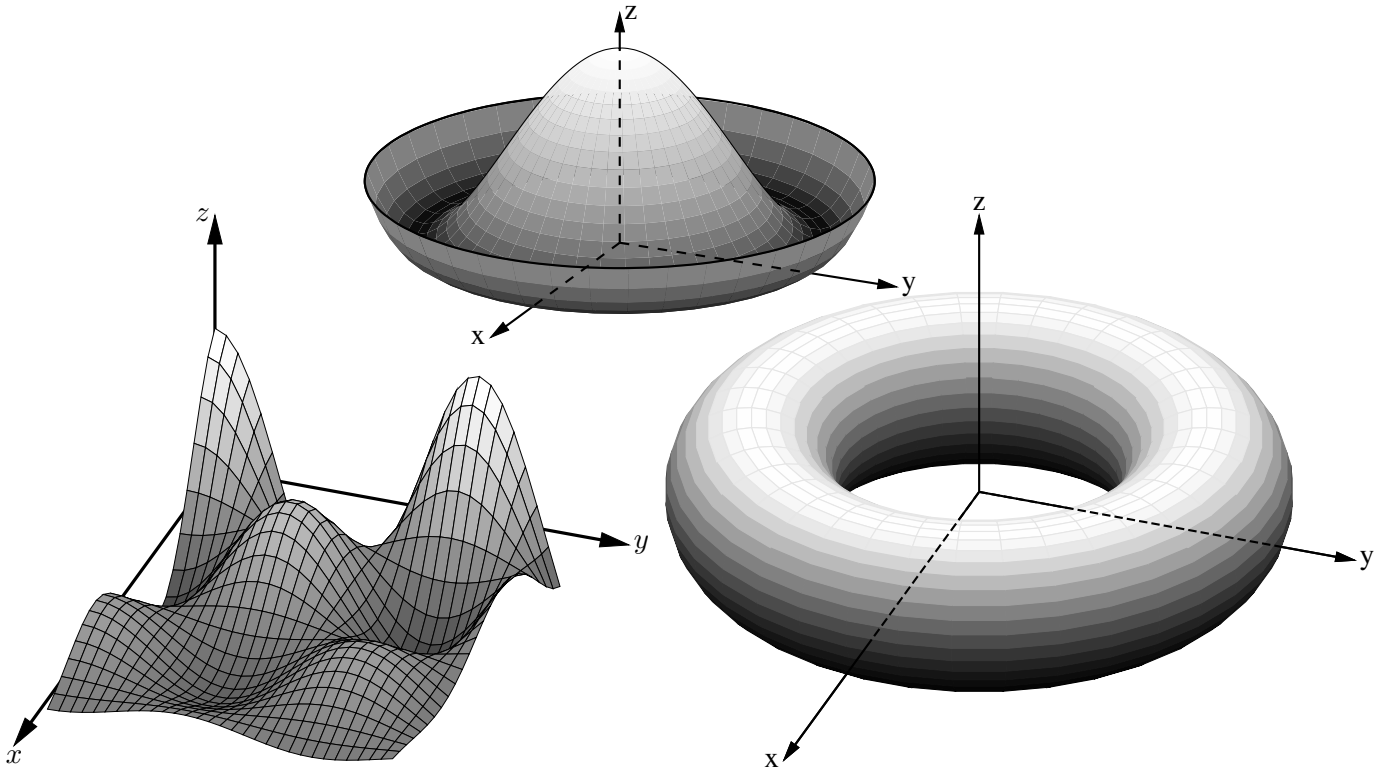


Figure 97: Plotting surfaces using gray scales [graysurf.m4].

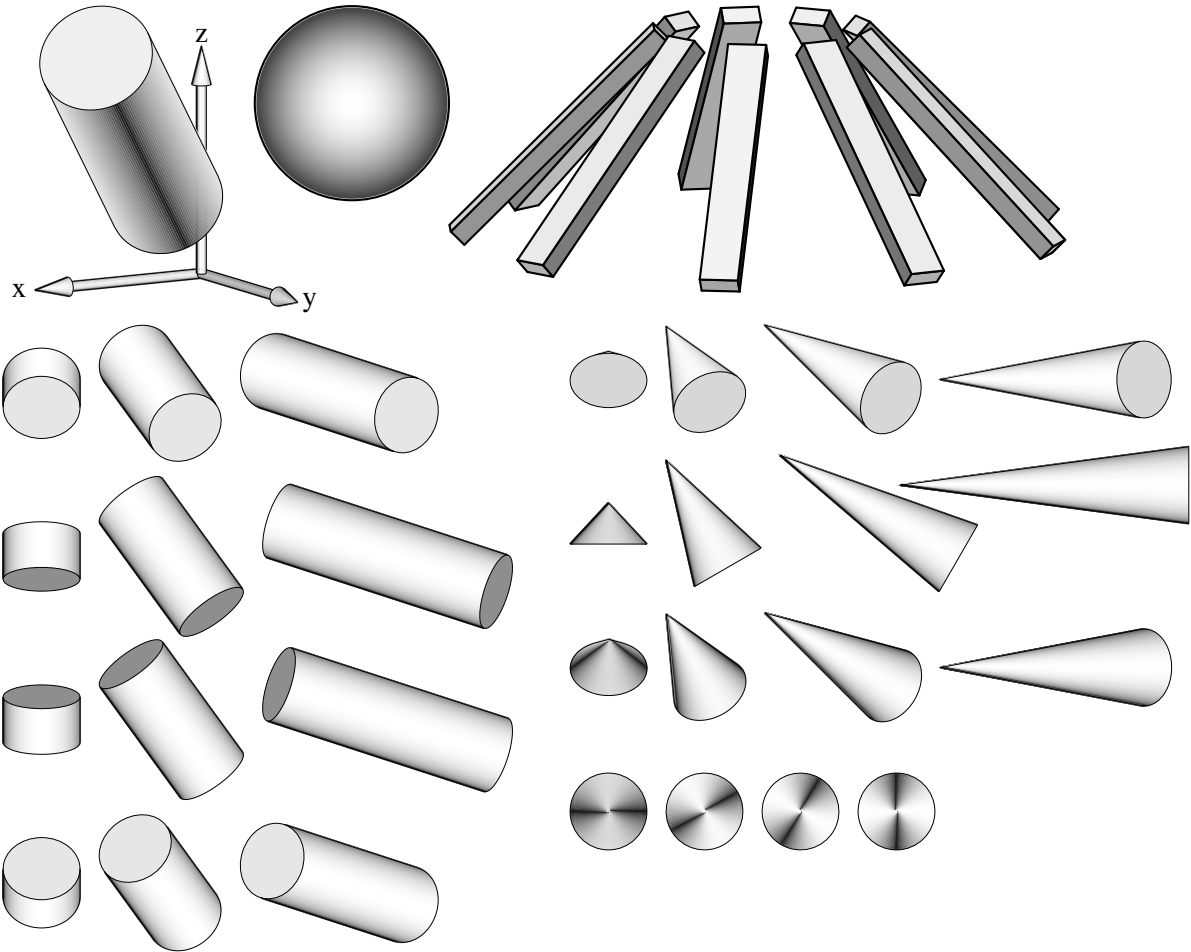


Figure 98: Basic shapes [shapes.m4].

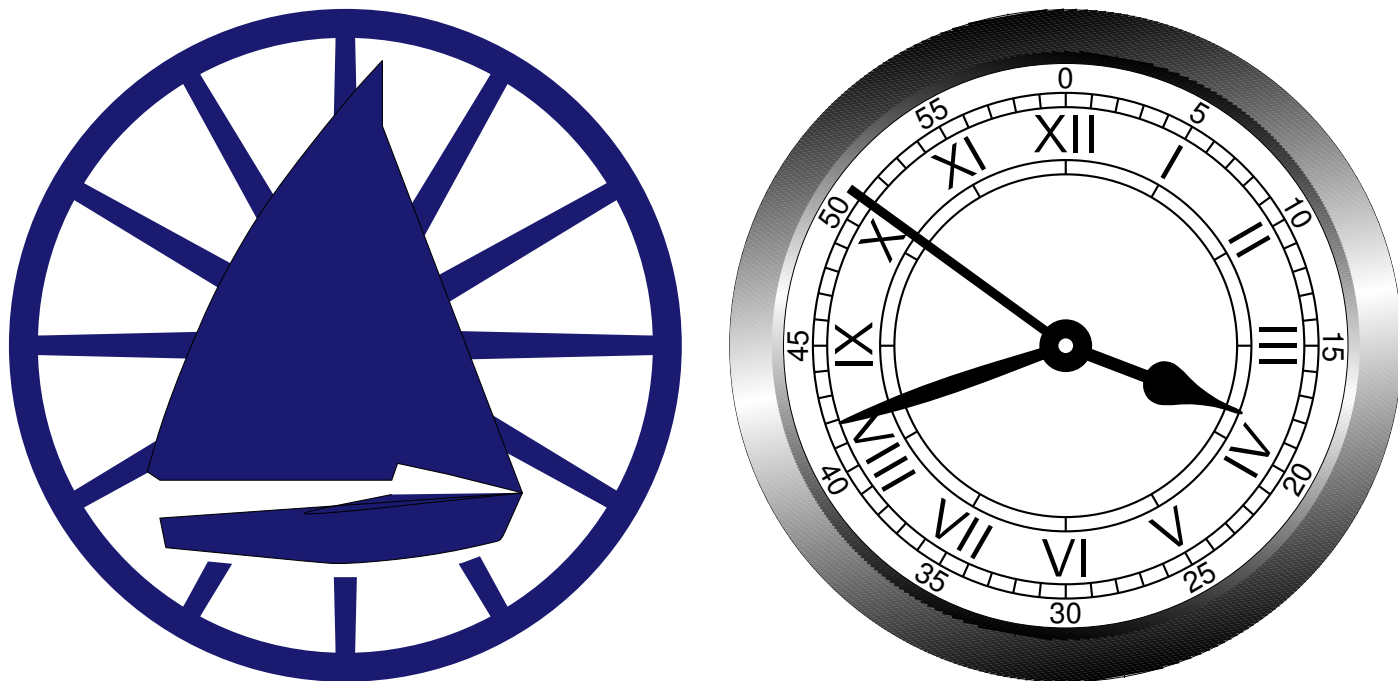


Figure 99: Conestoga Sailing Club (illustrating the filling of arbitrary shapes) and an antique clock face with shading and rotated text [csc.m4].

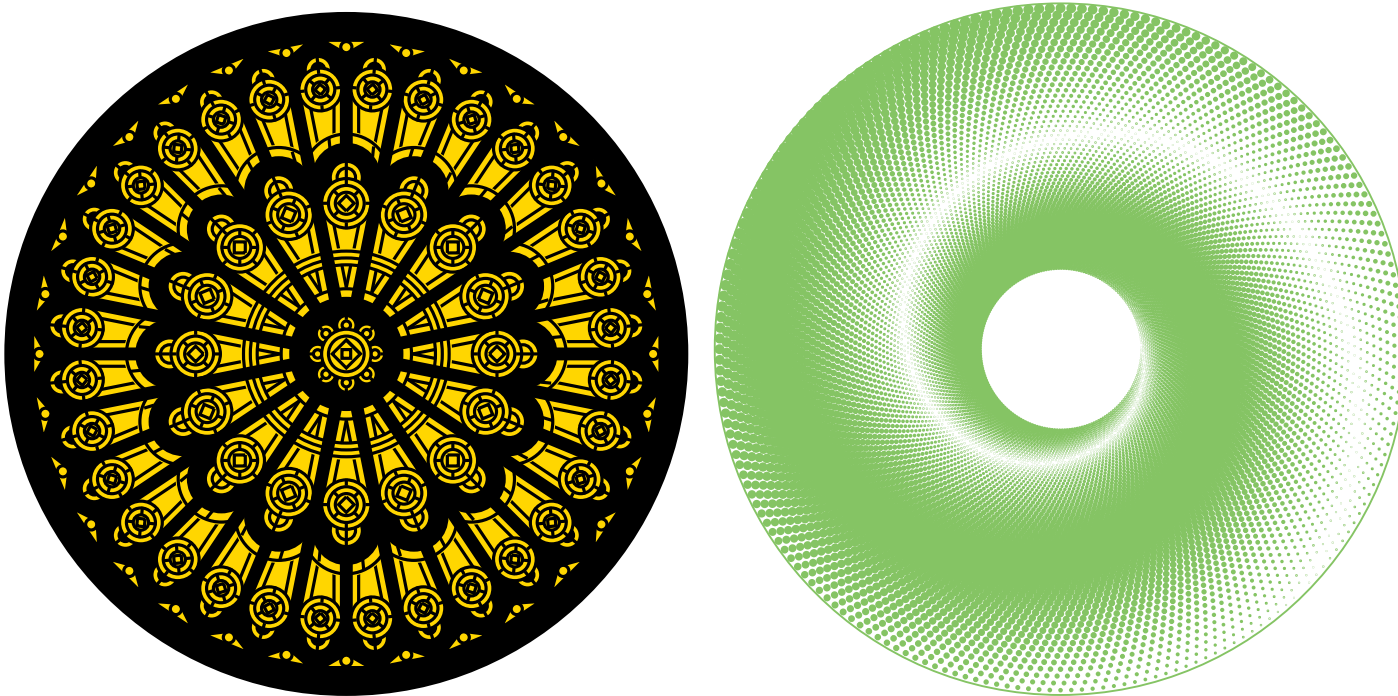


Figure 100: The left object, used for testing `dipic`, is redrawn from a detail of the set design for the musical *Dracula*. This consumes much  $\text{\LaTeX}$  main memory but can be produced directly as pdf using `dpic -d`, as svg using `dpic -v`, or as postscript using `dpic -r` since no text formatting is required. The right object adjusts the size of dots to produce a halftone effect [rose.m4].

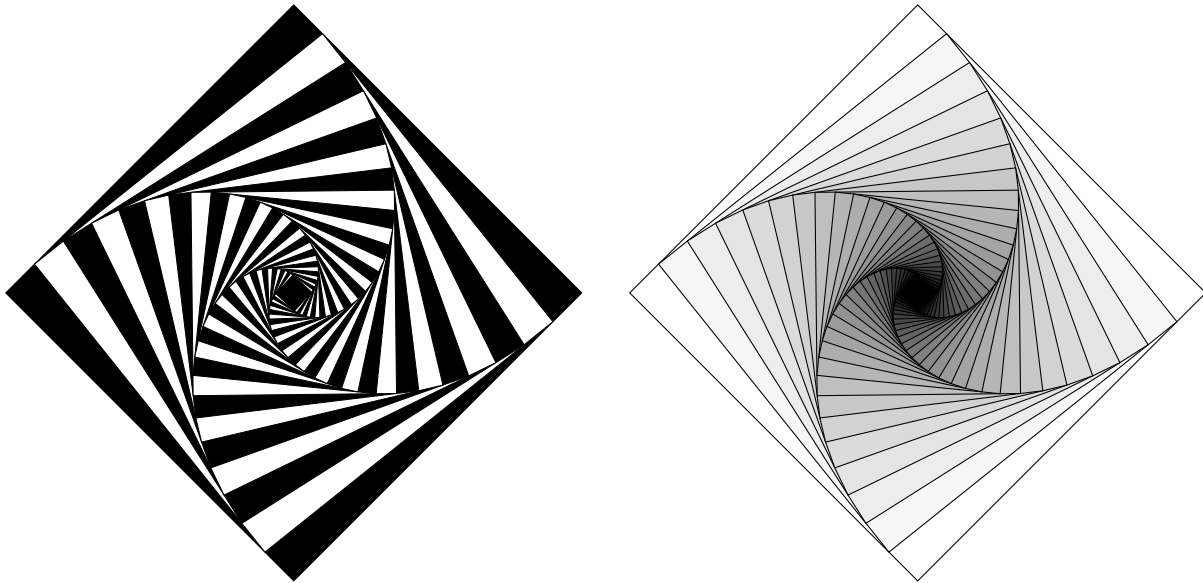


Figure 101: Variations on M. Goossens, S. Rahtz, and F. Mittelbach, *The L<sup>A</sup>T<sub>E</sub>X Graphics Companion*, Addison-Wesley 1997, pp. 57-58 [diamond.m4].

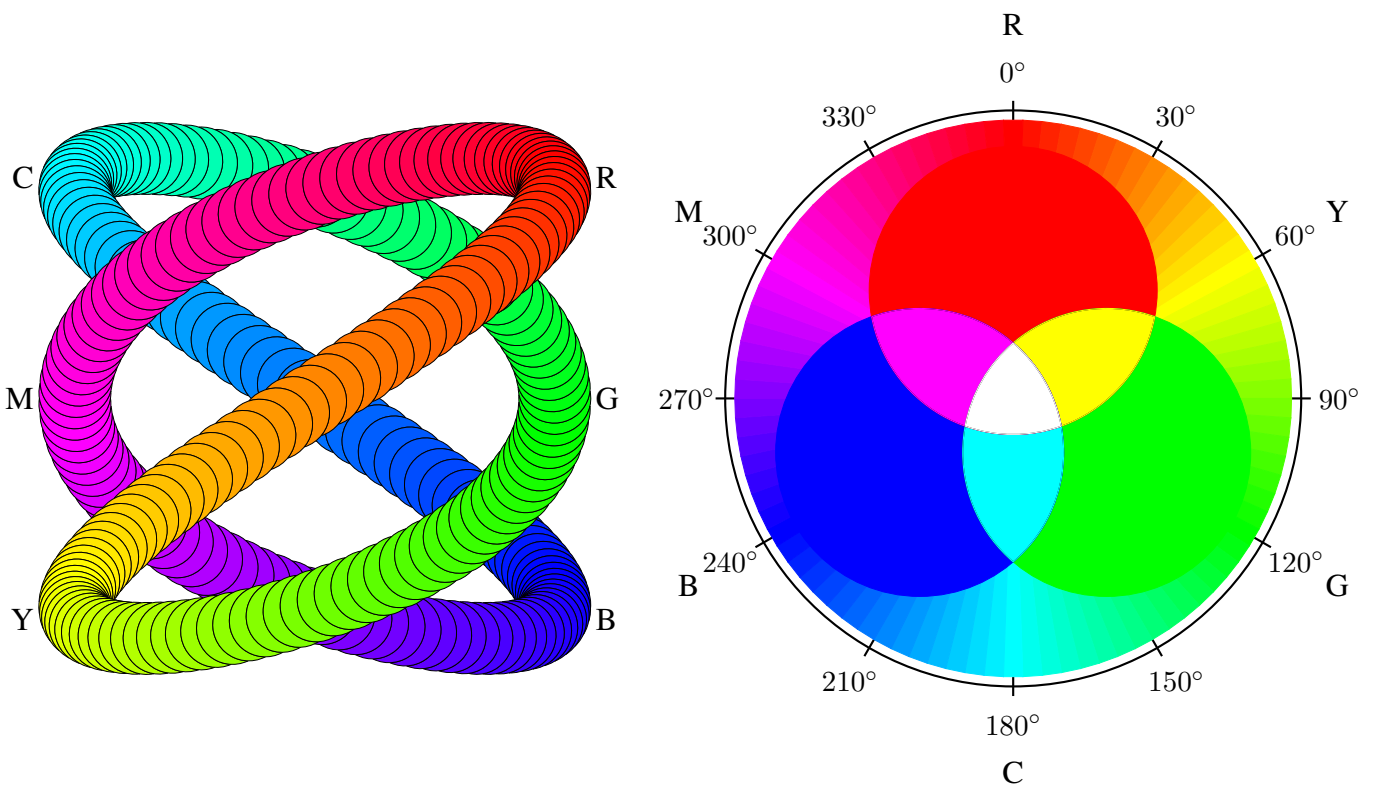


Figure 102: An exercise in calculating RGB colours [worm.m4].

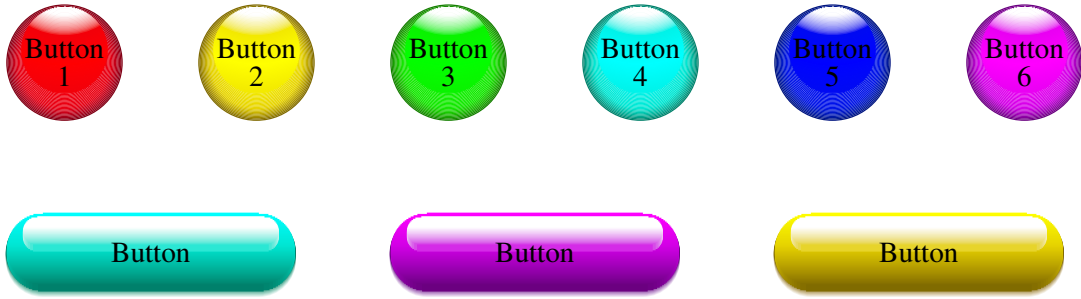


Figure 103: Shading in color [Buttons.m4].

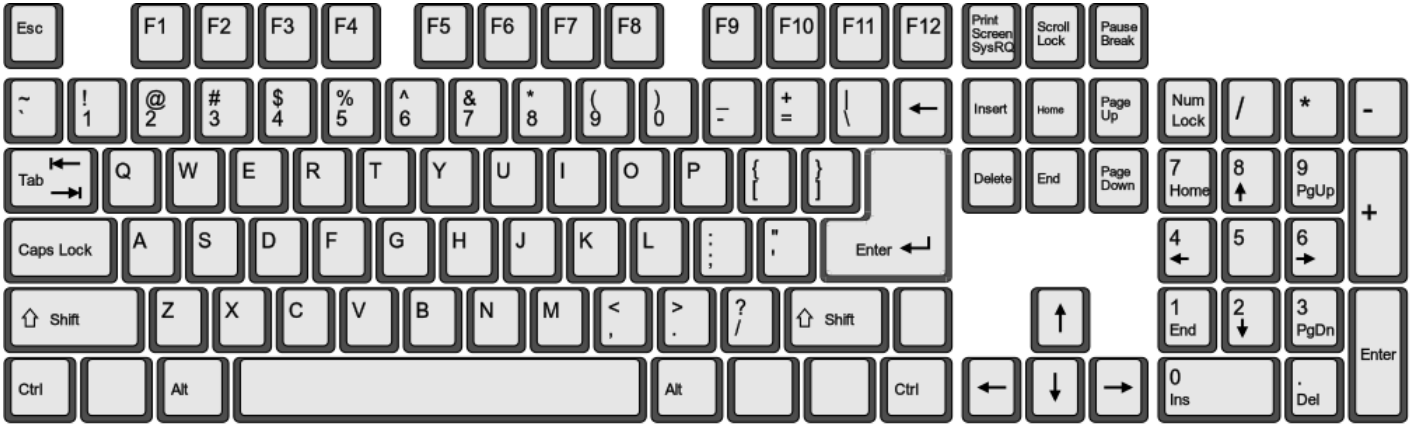


Figure 104: This diagram has been produced as svg with dpic -v (then converted to pdf for inclusion in examples.pdf) [keyboard.m4].

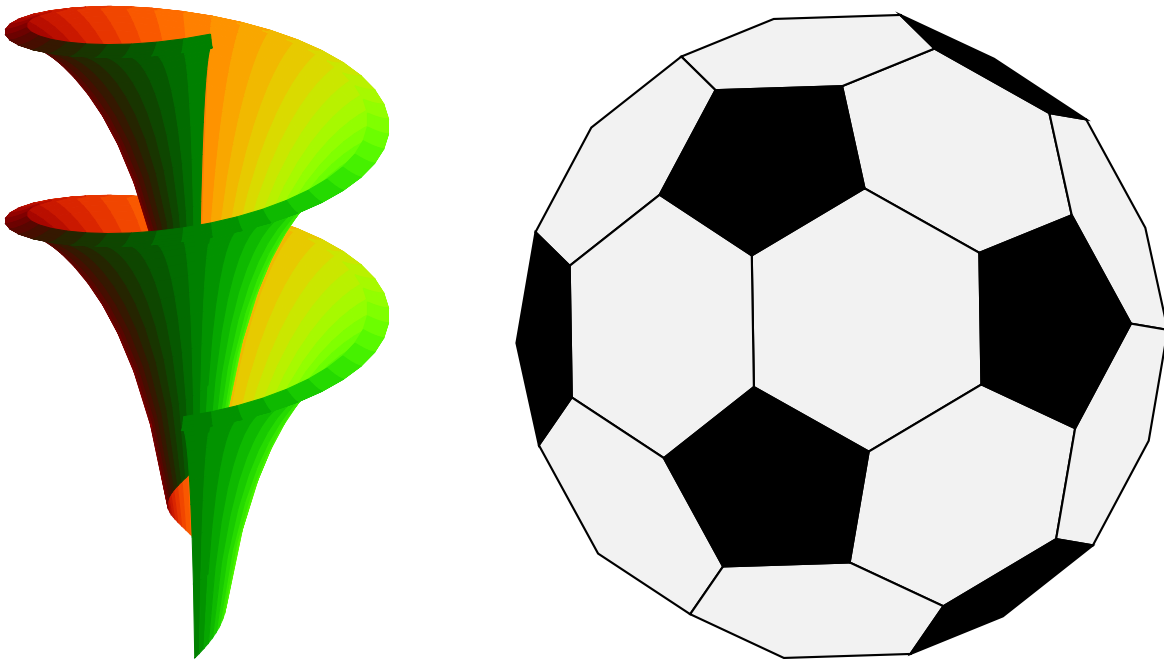


Figure 105: Dini surface and an icosahedron [Dini.m4].

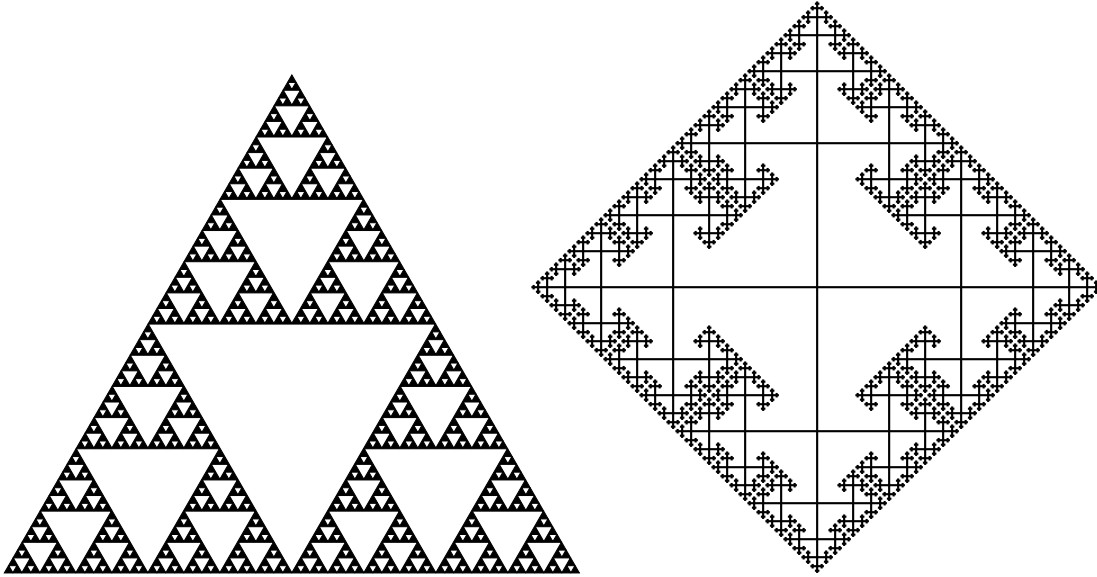


Figure 106: The Sierpinski triangle and a Cayley graph: tests of pic macro recursion [Sierpinski.m4].

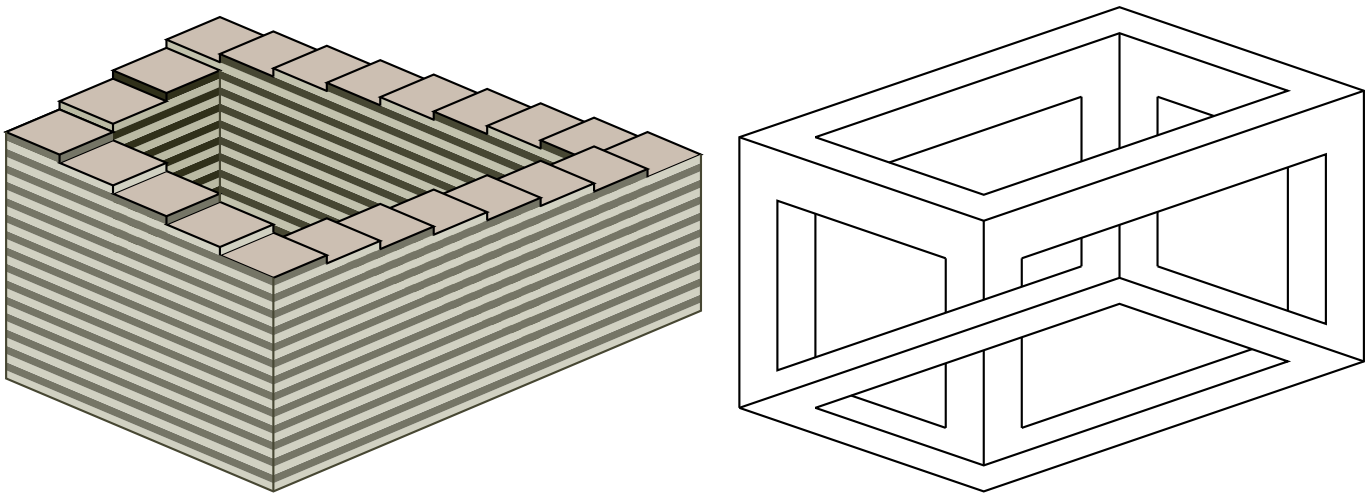


Figure 107: Penrose stairs and an Escher-like object [Escher.m4].

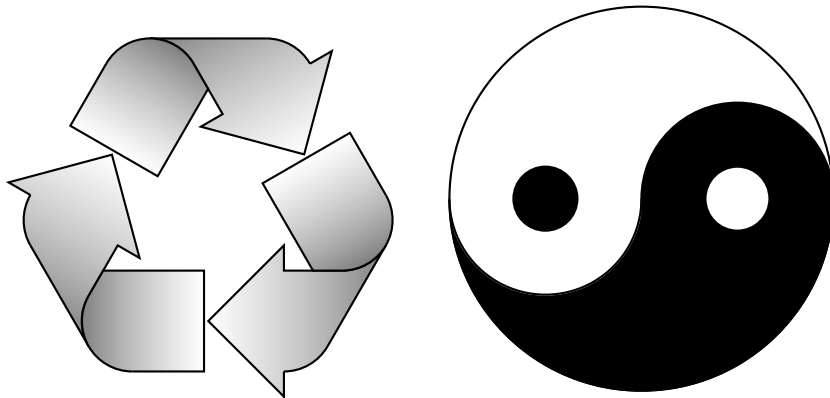


Figure 108: Modest repetition and partial fill [recycle.m4].

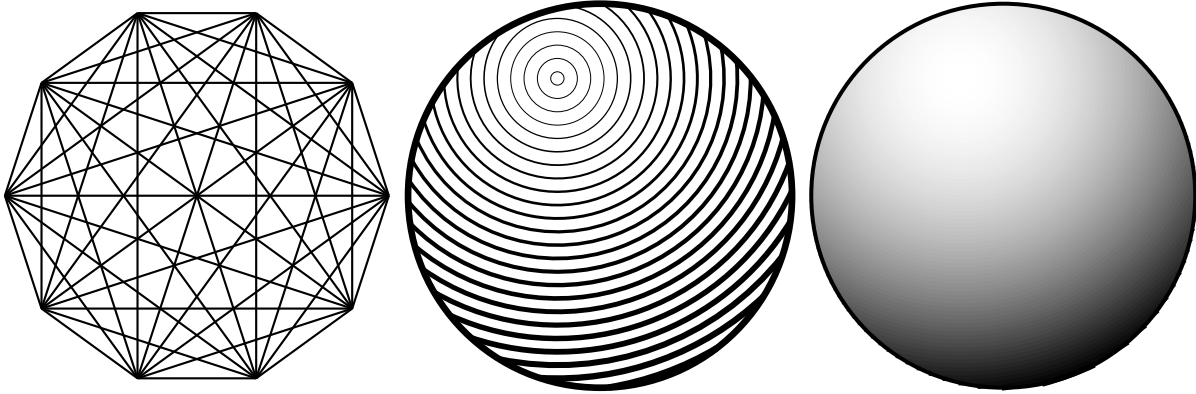


Figure 109: Simple diagrams that are easily drawn by looping [ex15.m4].

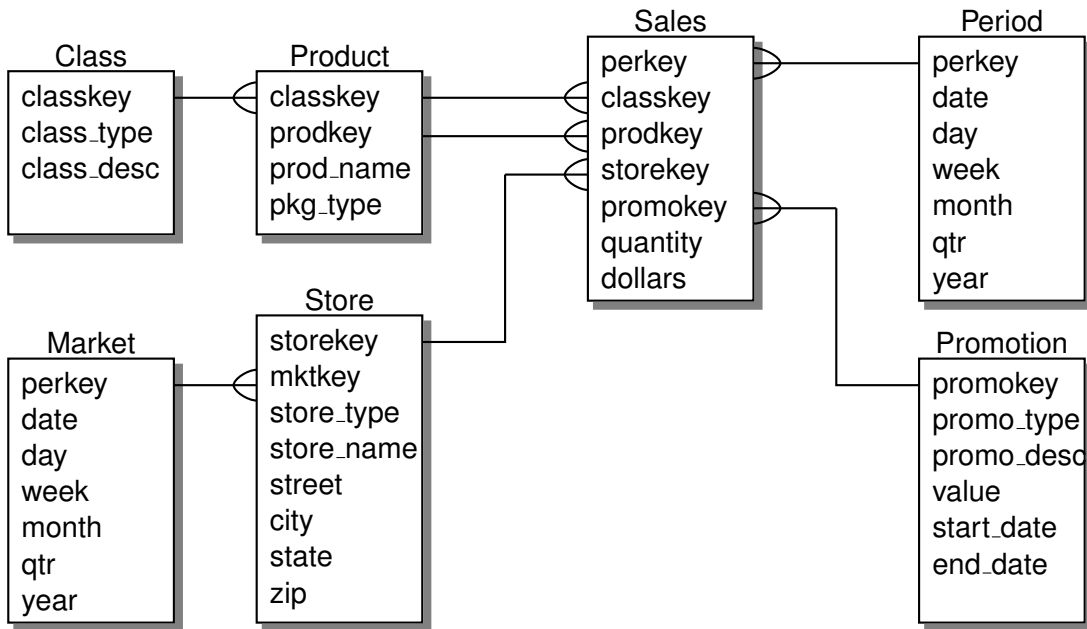


Figure 110: Illustrating shadebox and a custom crowfoot line termination [Crow.m4].



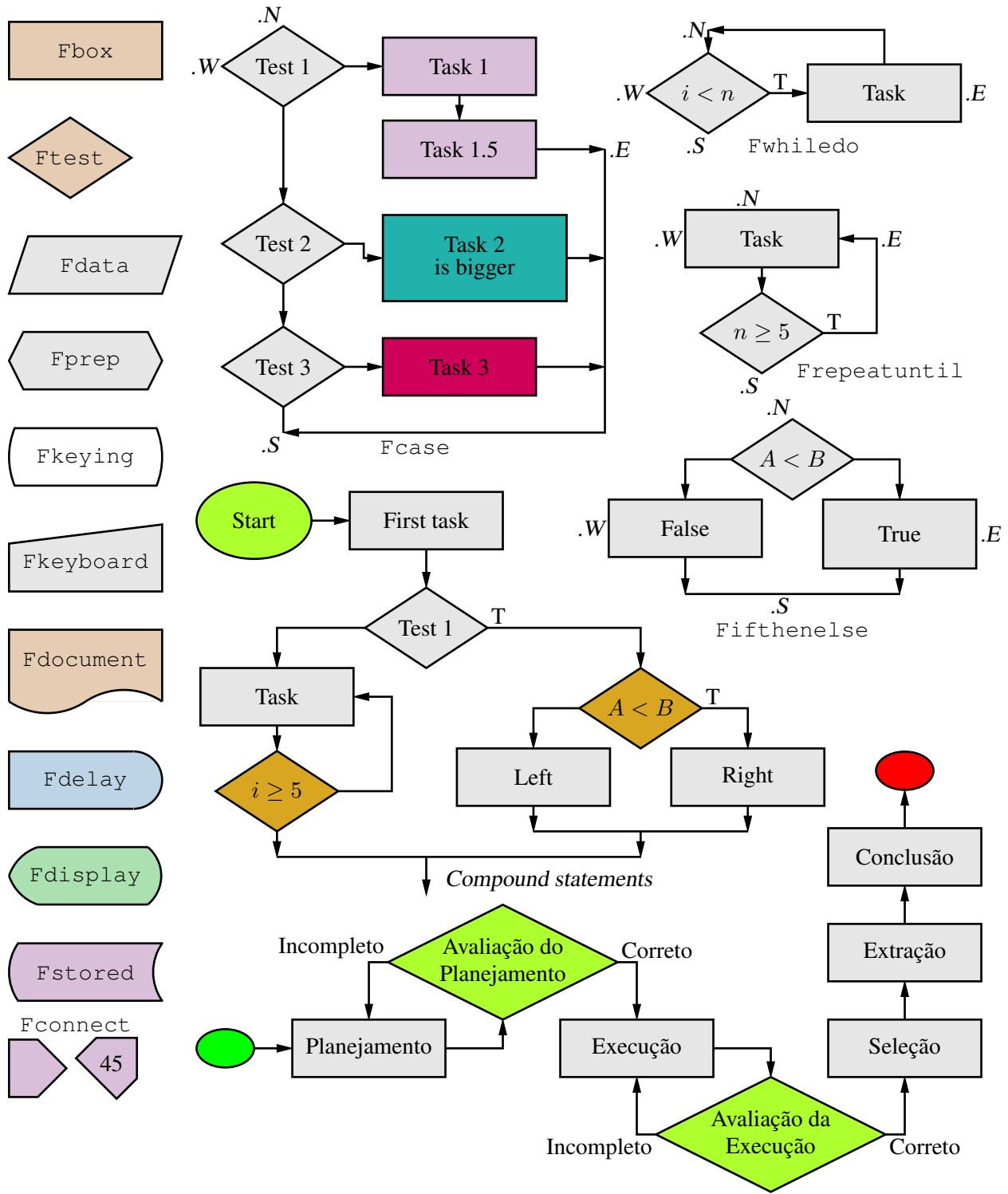


Figure 111: A flowchart sampler [Flow.m4].

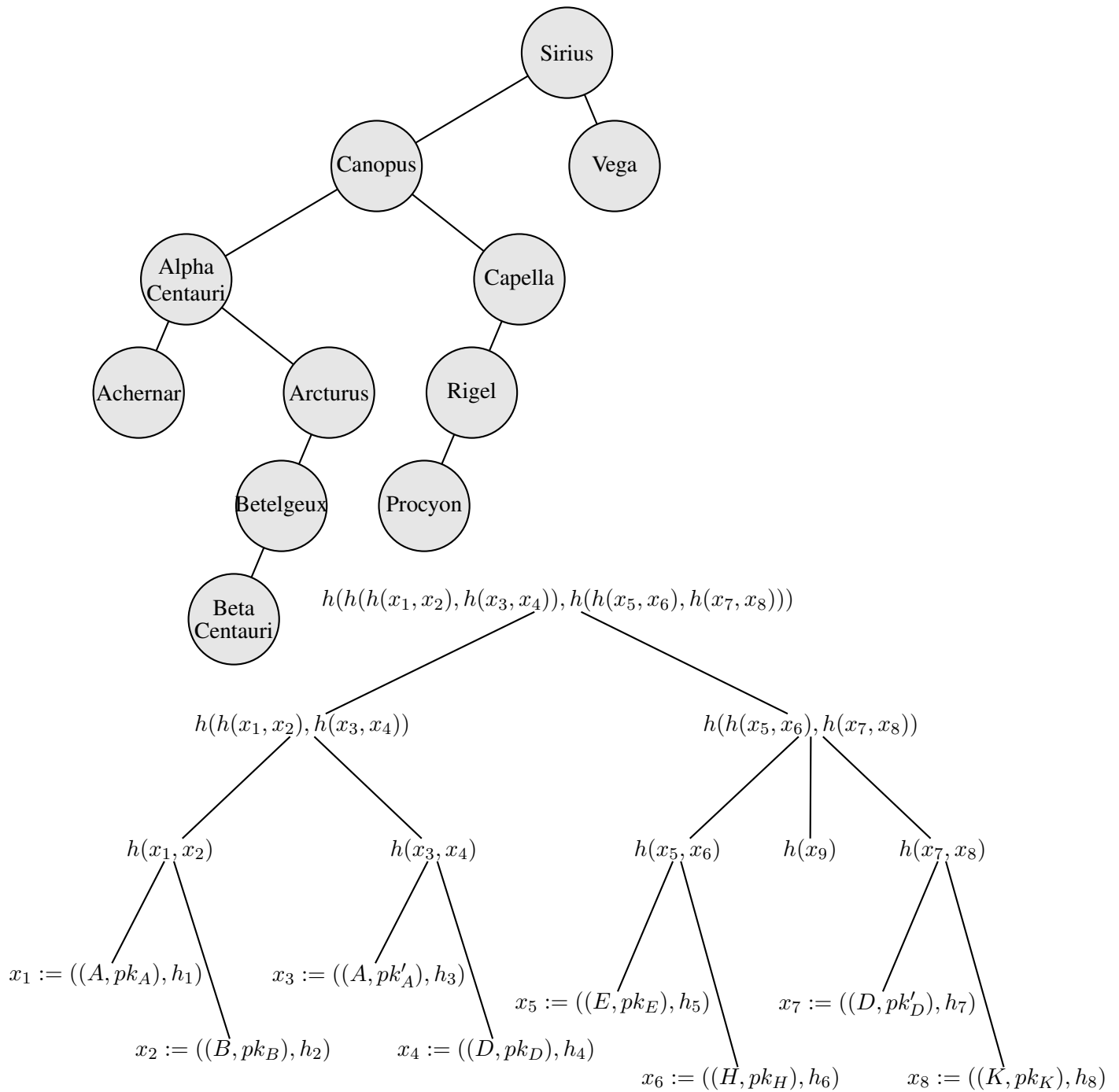


Figure 112: Trees [Btree.m4].



Figure 113: Overlaying a figure with line graphics [Incleps.m4].