

## Examples: Version 9.7

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*”.

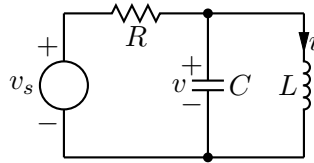


Figure 1: The quick-start example from the manual [quick.m4].

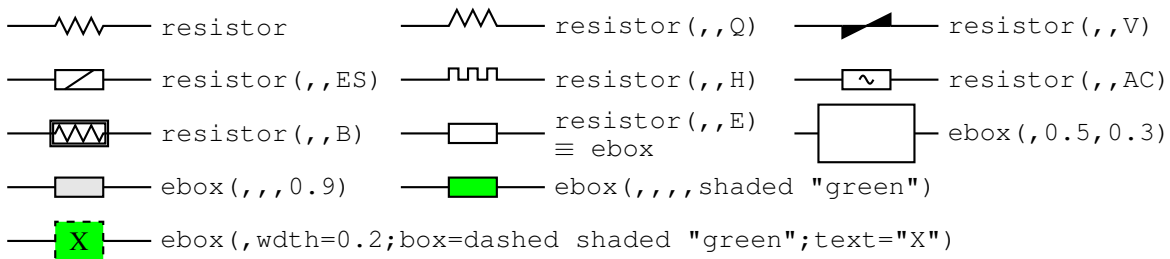


Figure 2: Resistors, showing some variations and the ebox [Resistors.m4].

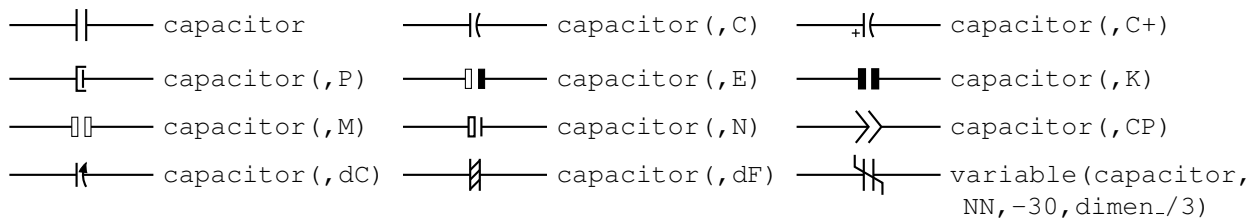


Figure 3: Capacitors, showing some variations [Capacitors.m4].



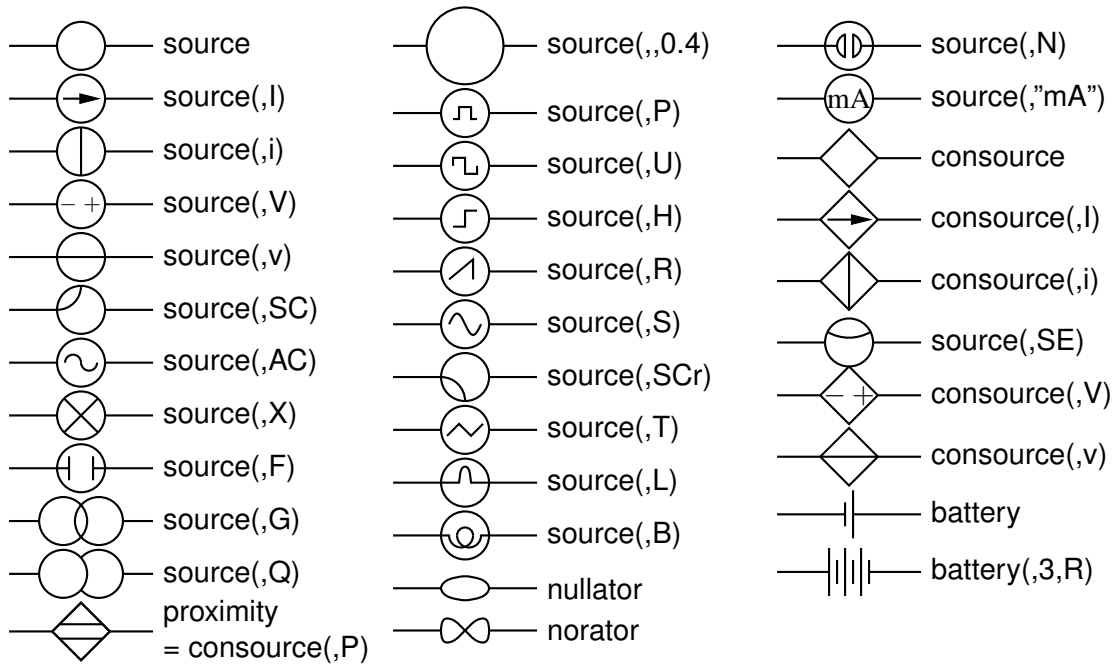


Figure 8: Sources and source-like elements [Sources.m4].

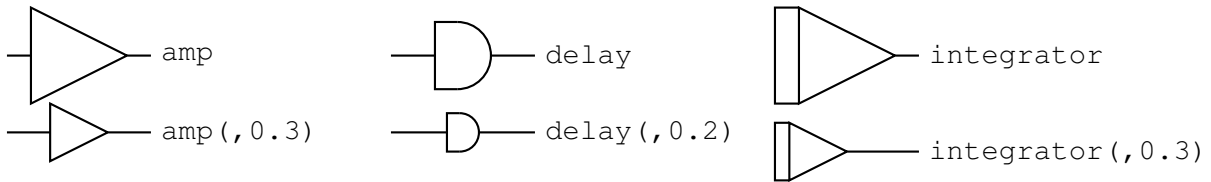


Figure 9: Macros amp, delay, and integrator [AmpTable.m4].

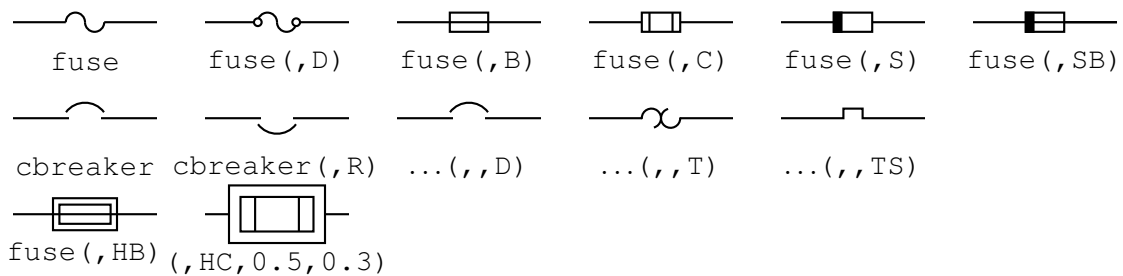


Figure 10: Macros fuse and cbreaker [Fuses.m4].

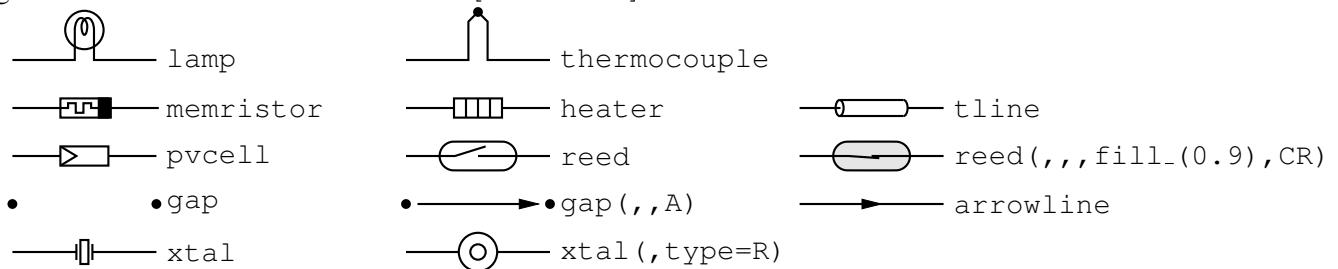


Figure 11: Additional two-terminal elements [MoreTable.m4].

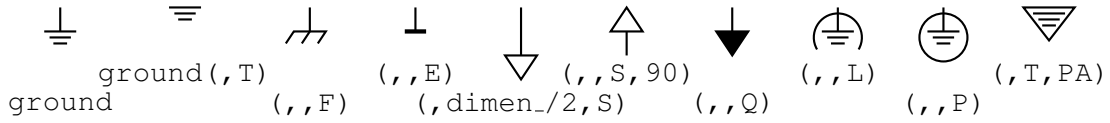


Figure 12: Ground symbols [Grounds.m4].

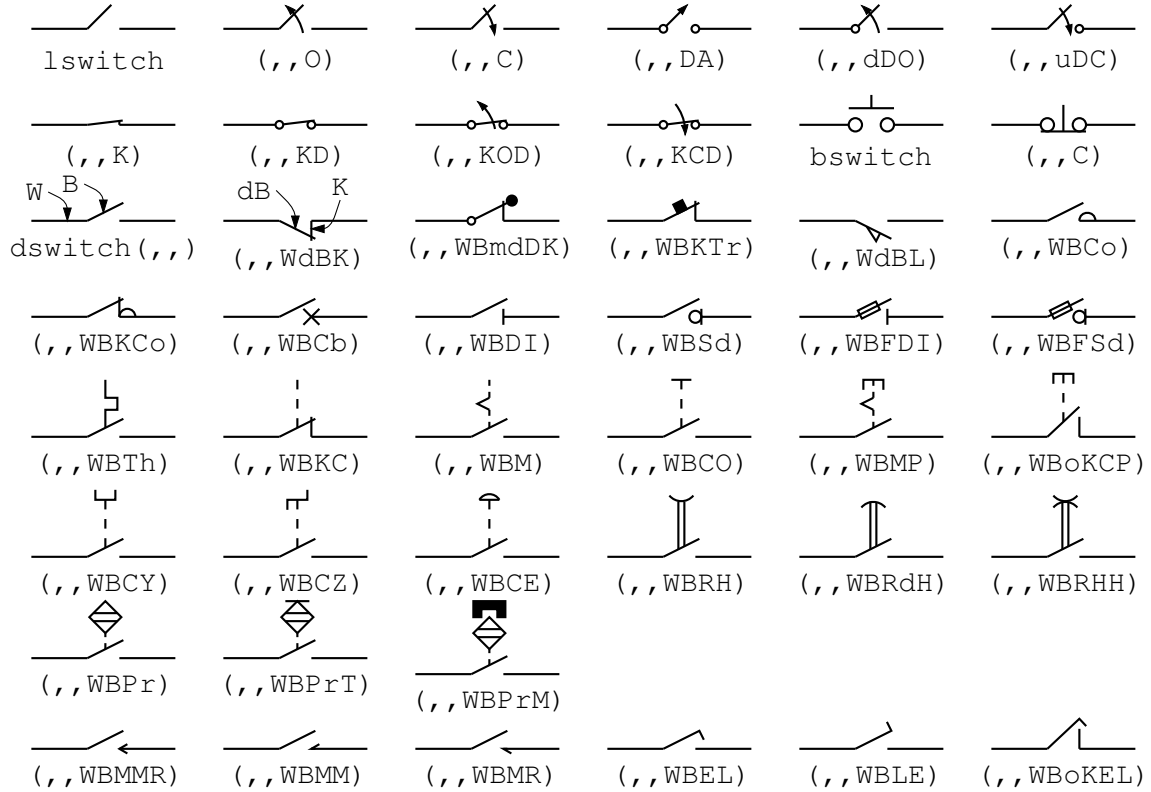


Figure 13: The switch macros;  $\text{switch}(,,L|B|D)$  is a wrapper for  $\text{lswitch}$ ,  $\text{bswitch}$ , and  $\text{dswitch}$  [Switches.m4].

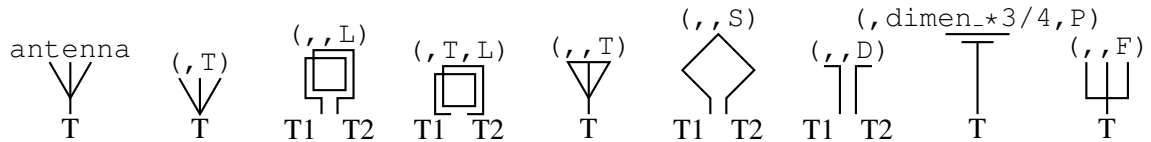


Figure 14: Antenna symbols [Antennas.m4].

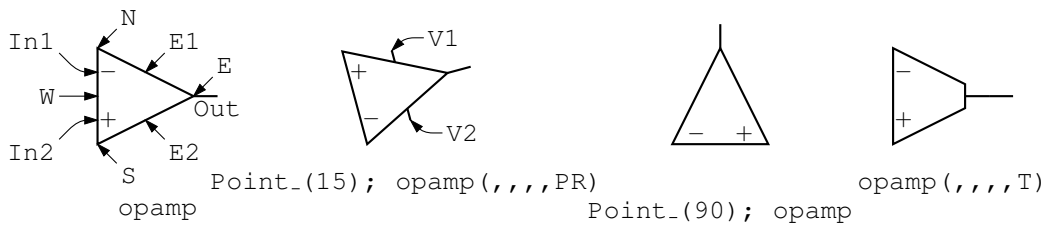


Figure 15: The opamp [Opamp.m4].

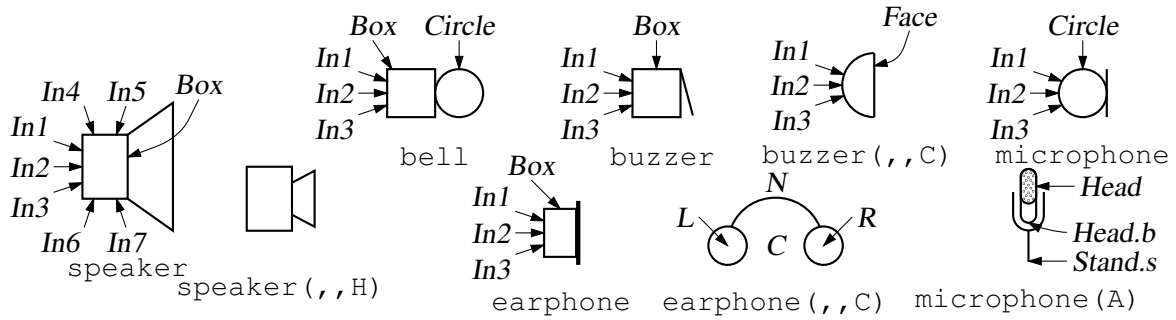


Figure 16: Audio elements [Audio.m4].

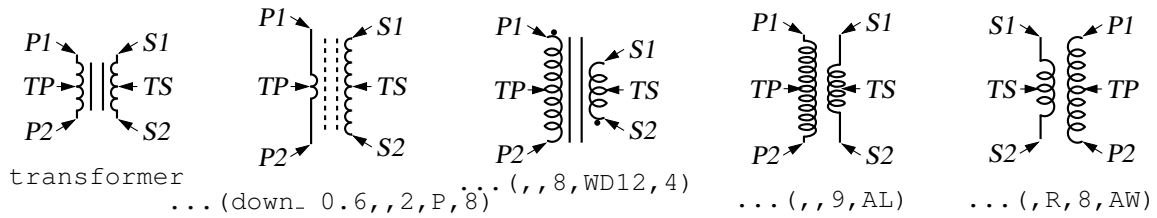


Figure 17: The transformer element, drawing direction down [Xform.m4].

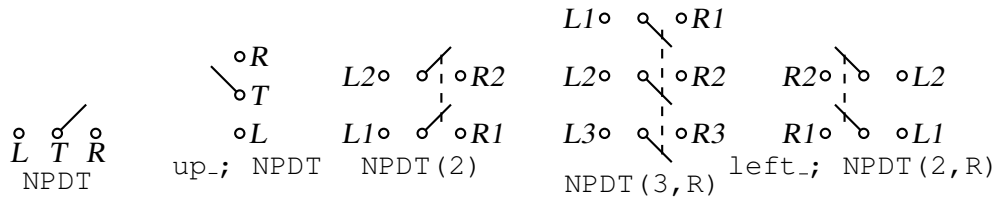


Figure 18: Double throw with the NPDT macro [NPDT.m4].

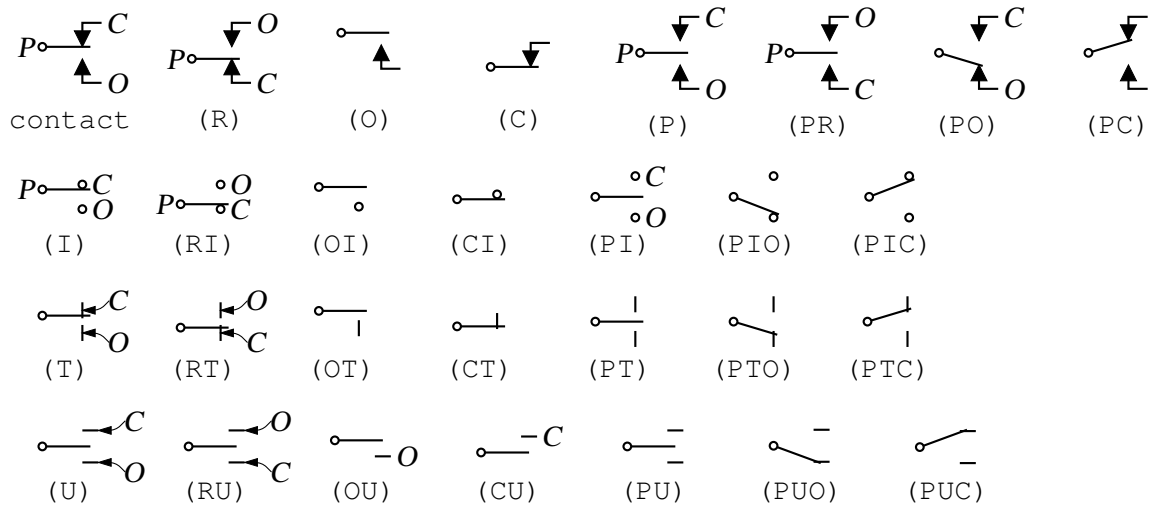


Figure 19: A non-exhaustive sampling of contact macro variations [Contact.m4].

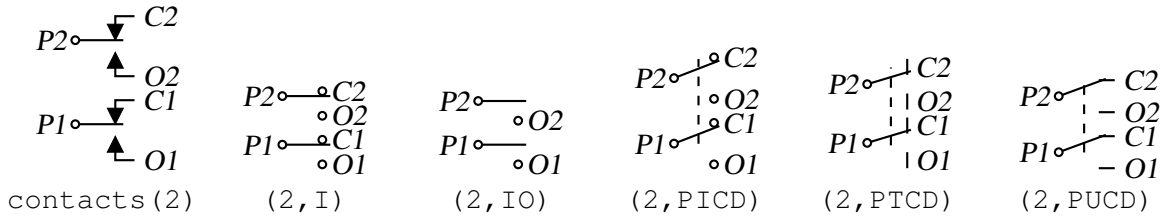


Figure 20: The contacts macro [Contacts.m4].

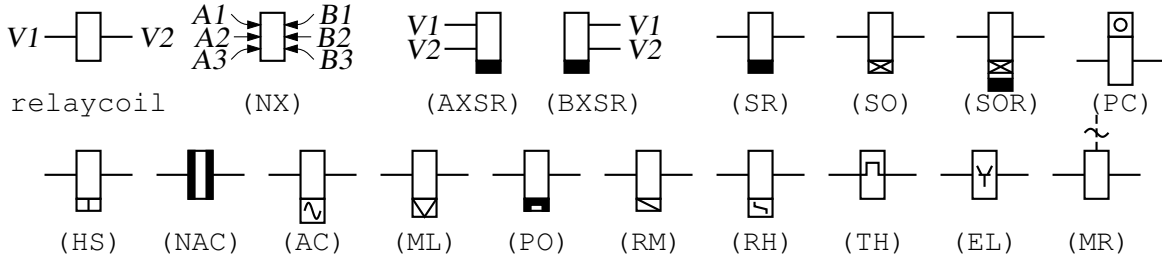


Figure 21: The relaycoil macro [relaycoil.m4].

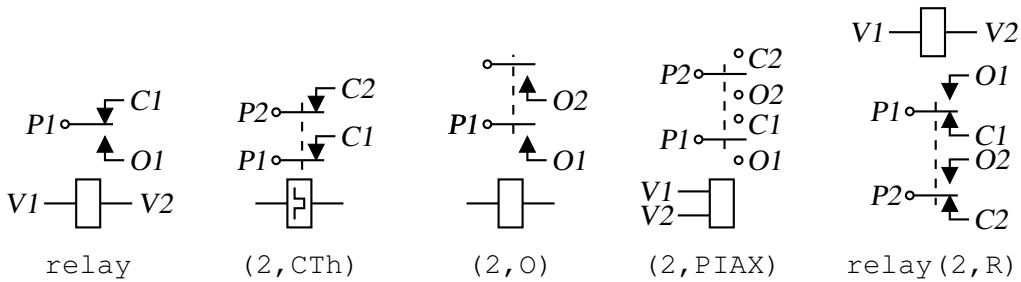


Figure 22: Some variants of the relay macro [Relay.m4].

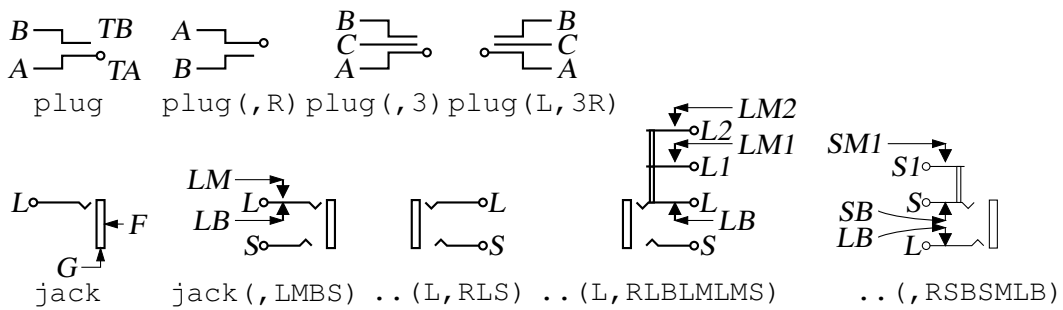


Figure 23: The jack and plug macros [Jack.m4].

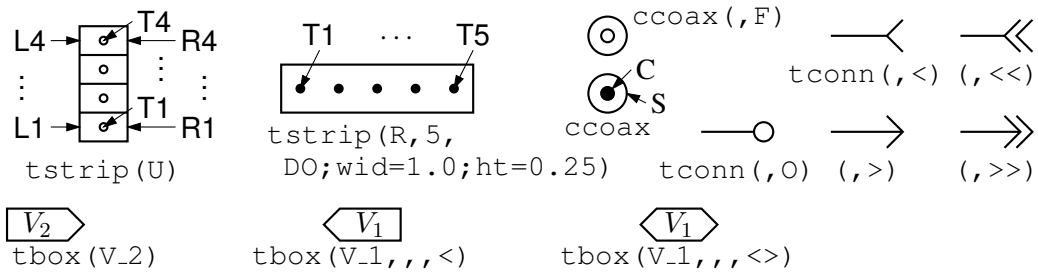


Figure 24: The tstrip, ccoax, tconn, and tbox macros [Conn.m4].

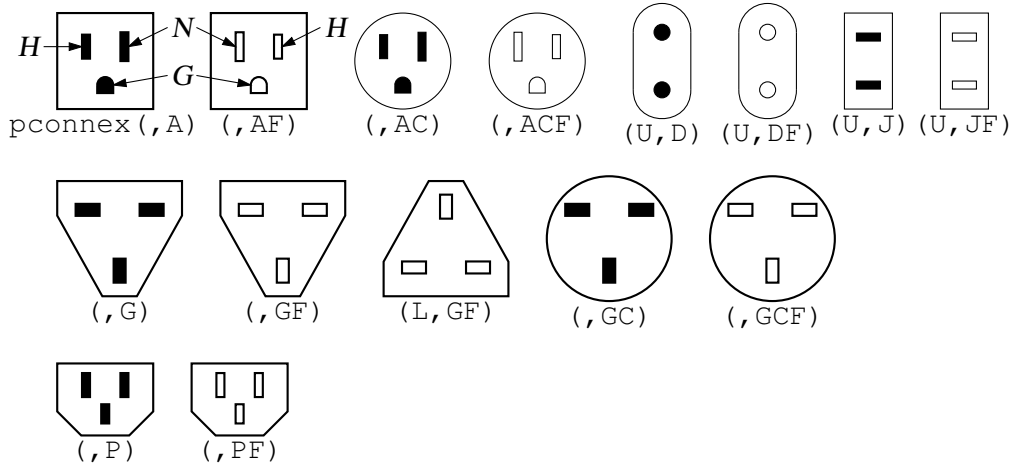


Figure 25: The pconnex macro [Pconn.m4].

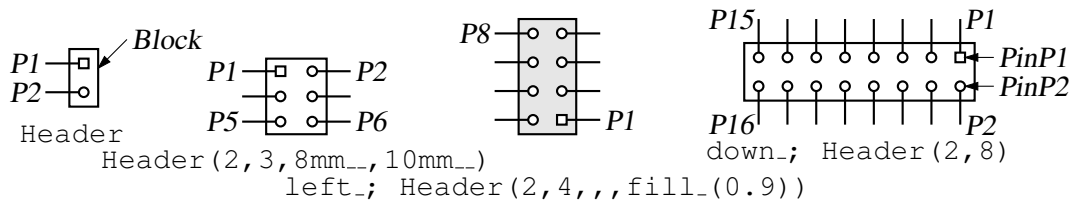


Figure 26: The Header macro [Headers.m4].

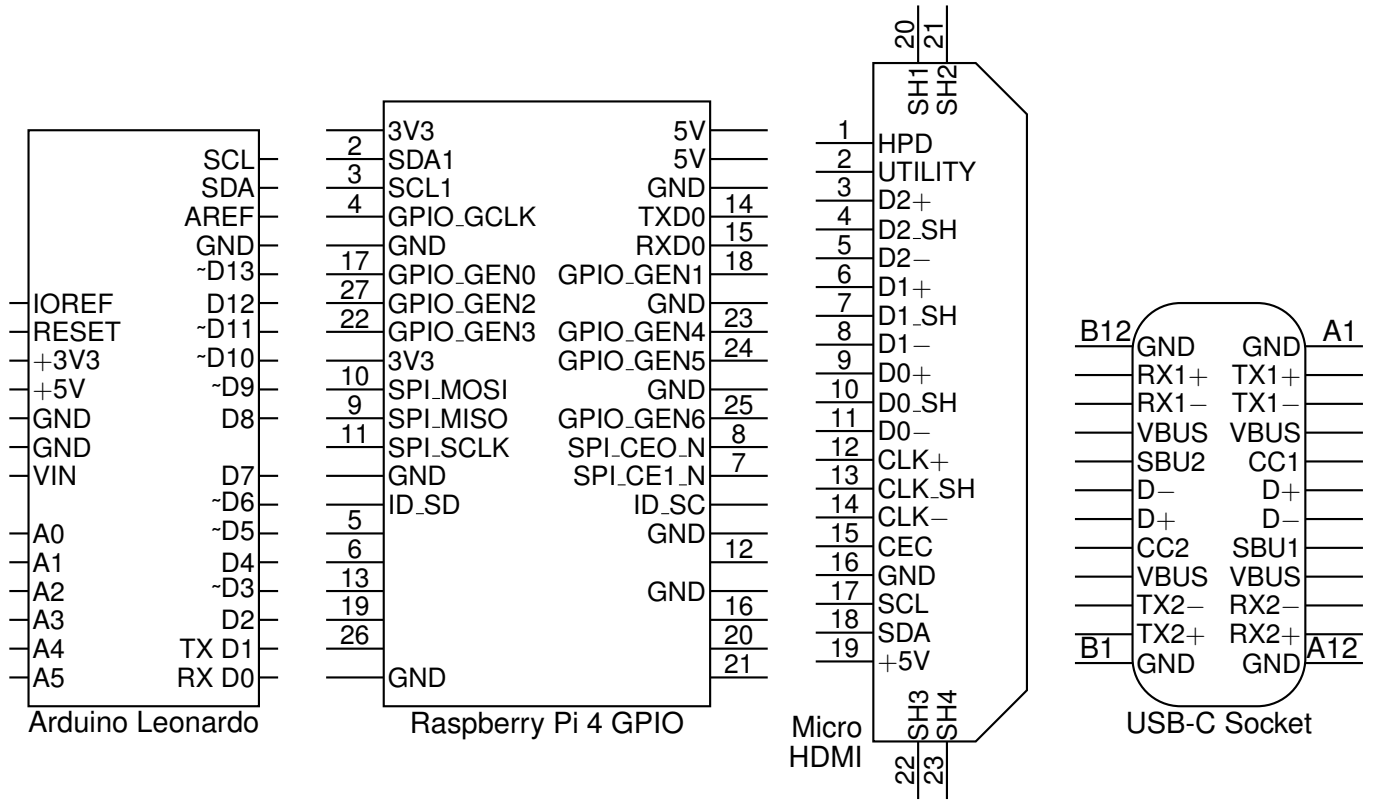


Figure 27: Some connectors with simple geometry and lists of labels [Connectors.m4].

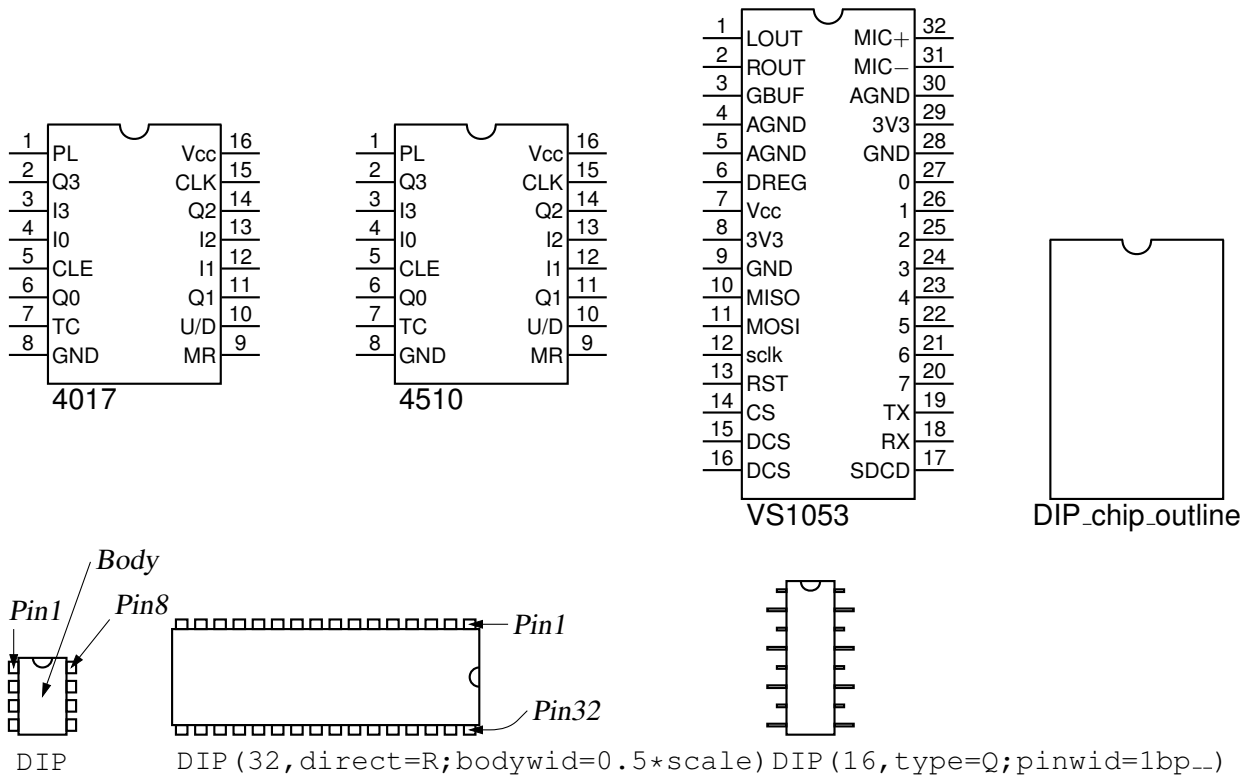


Figure 28: IC package outlines [Chips.m4].



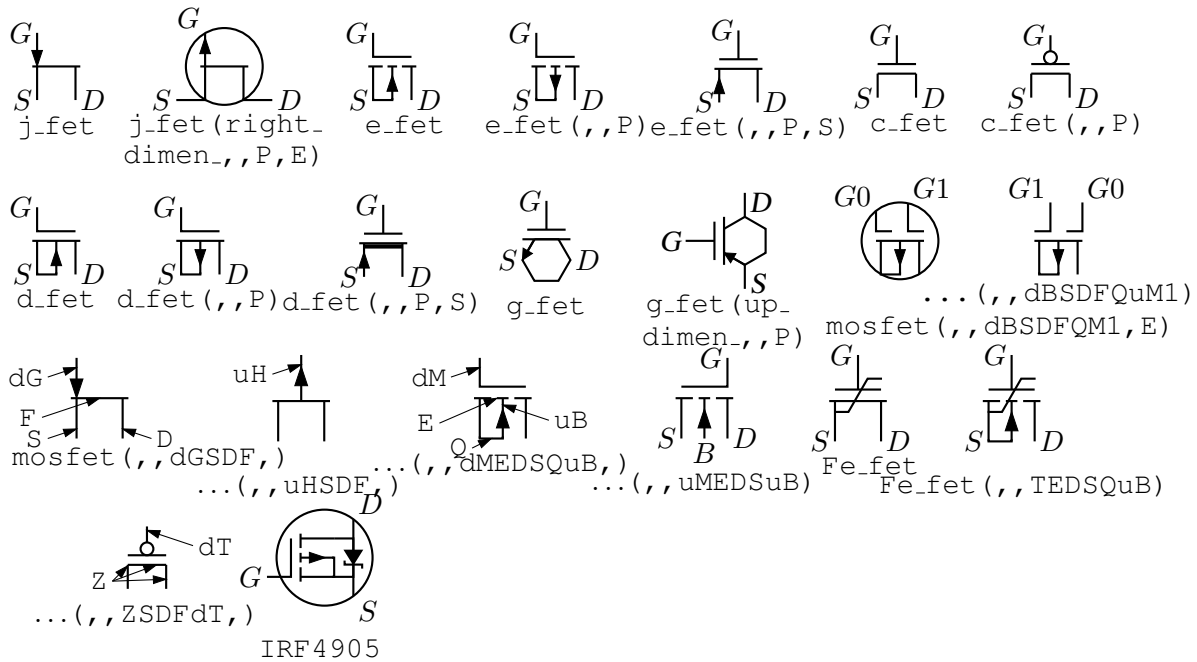


Figure 29: FETs, showing programmable components and example customizations [fet.m4].

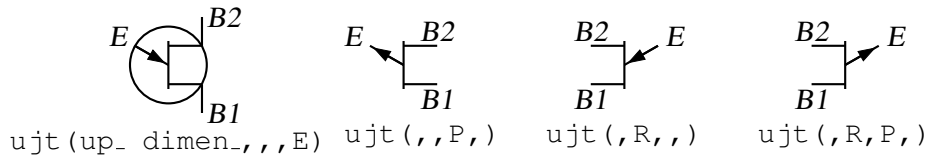


Figure 30: UJT examples [ujt.m4].

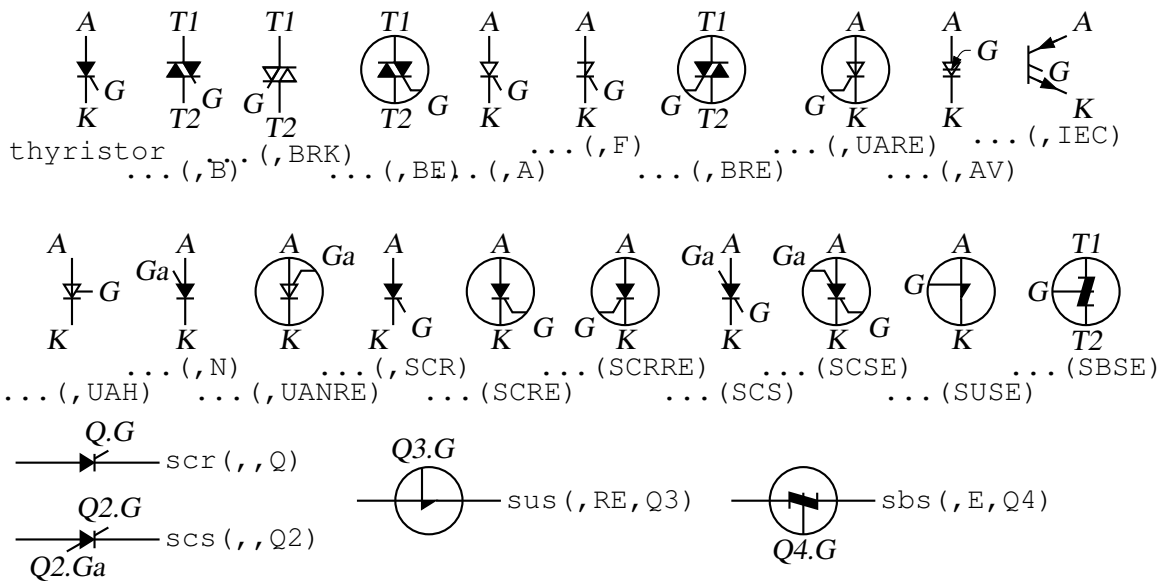


Figure 31: Thyristor examples [thyristor.m4].

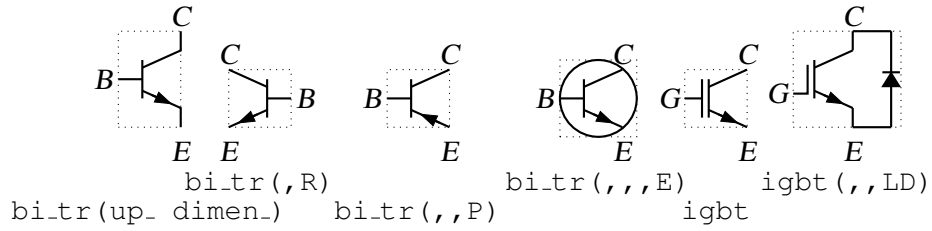


Figure 32: Bipolar transistors (drawing direction: up) [Bip.m4].

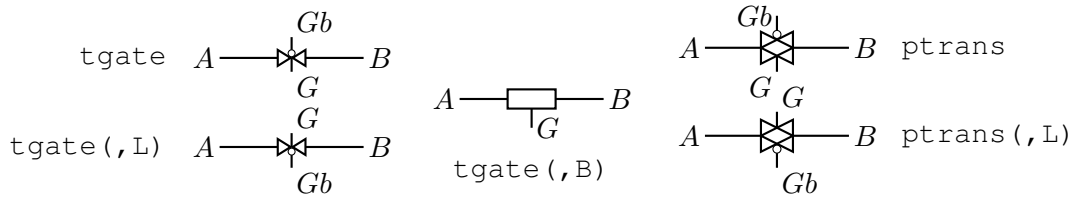


Figure 33: The tgate and ptrans elements [Tgate.m4].

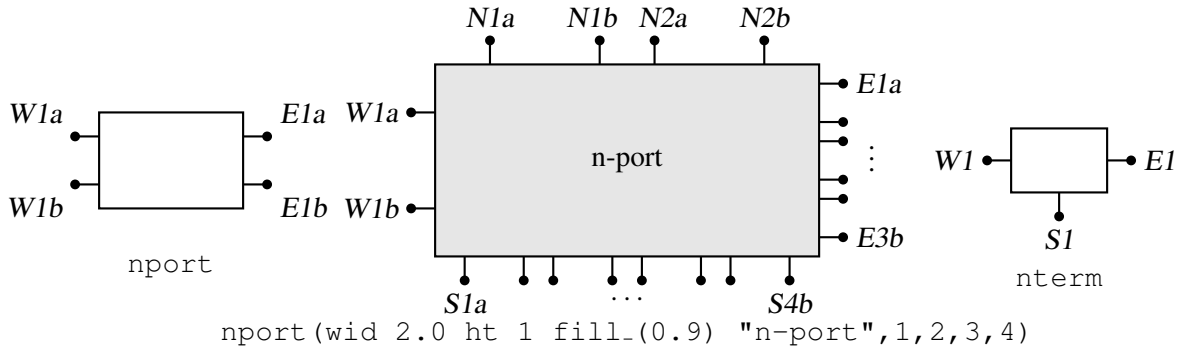


Figure 34: The nport and nterm macros [Nport.m4].

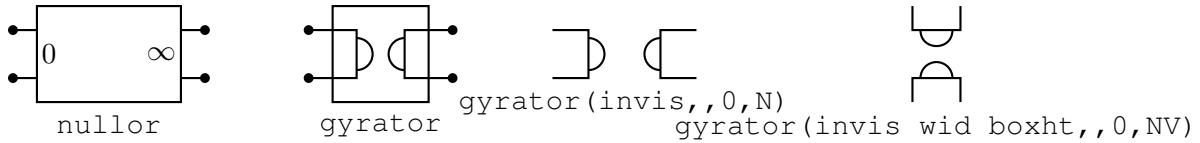


Figure 35: Some customizations of nport [NLG.m4].

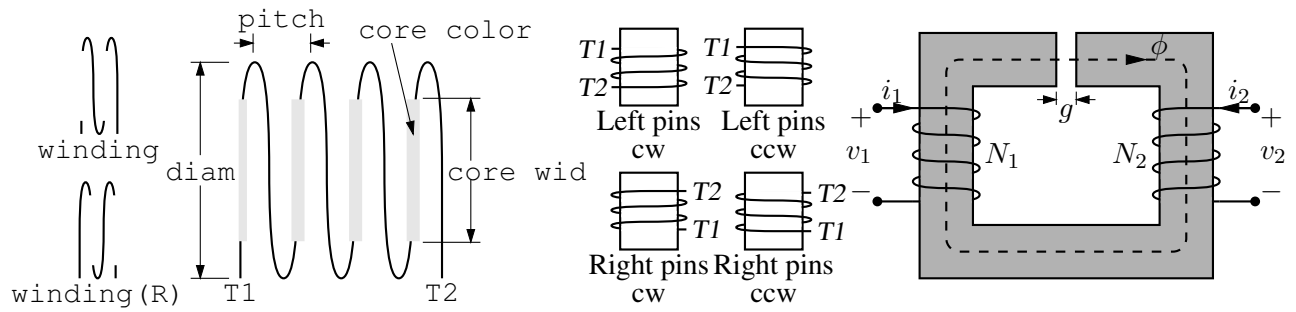


Figure 36: The macro winding (L|R, diam, pitch, turns, core wid, core color) [Windings.m4].

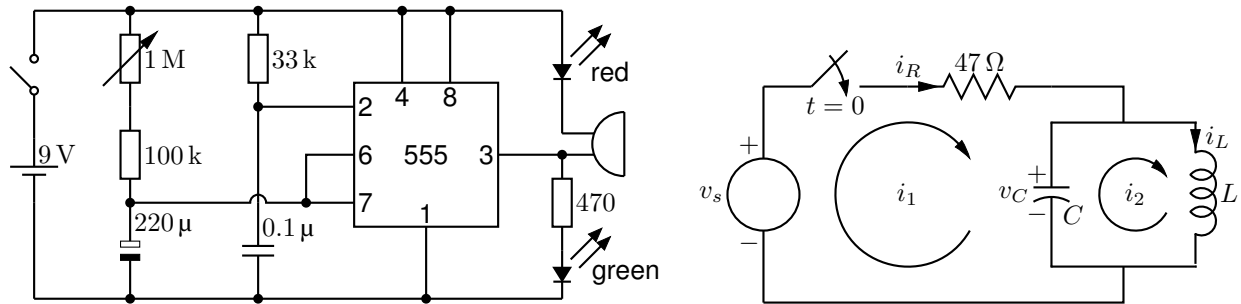


Figure 37: Two simple labeled circuits [ex01.m4].

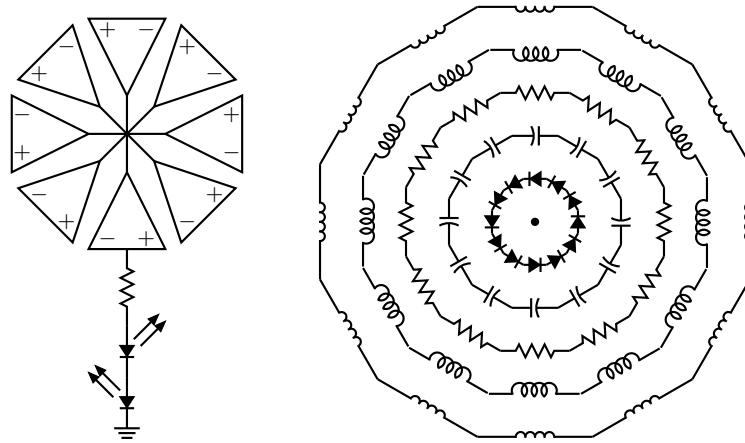


Figure 38: Elements at obtuse angles [ex02.m4].

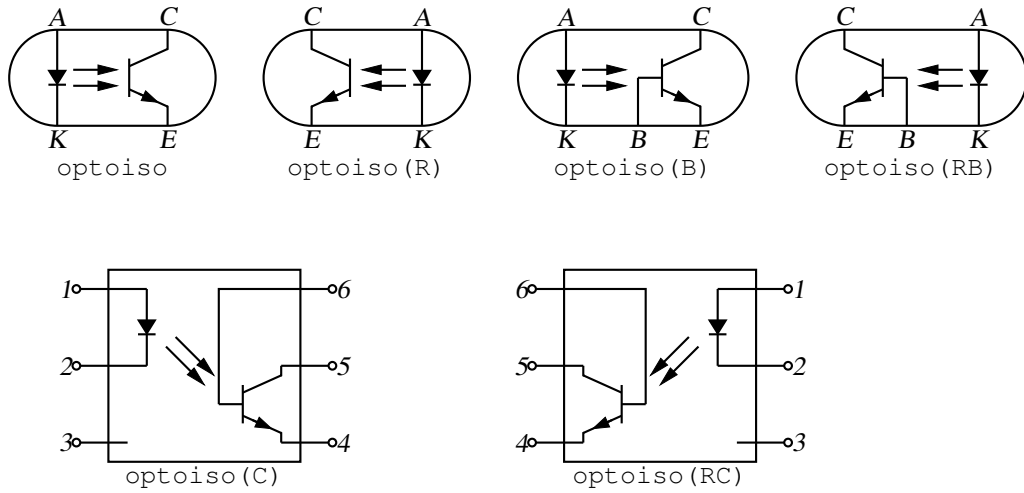


Figure 39: Optical isolator: a circuit with right or left orientation [Optoiso.m4].

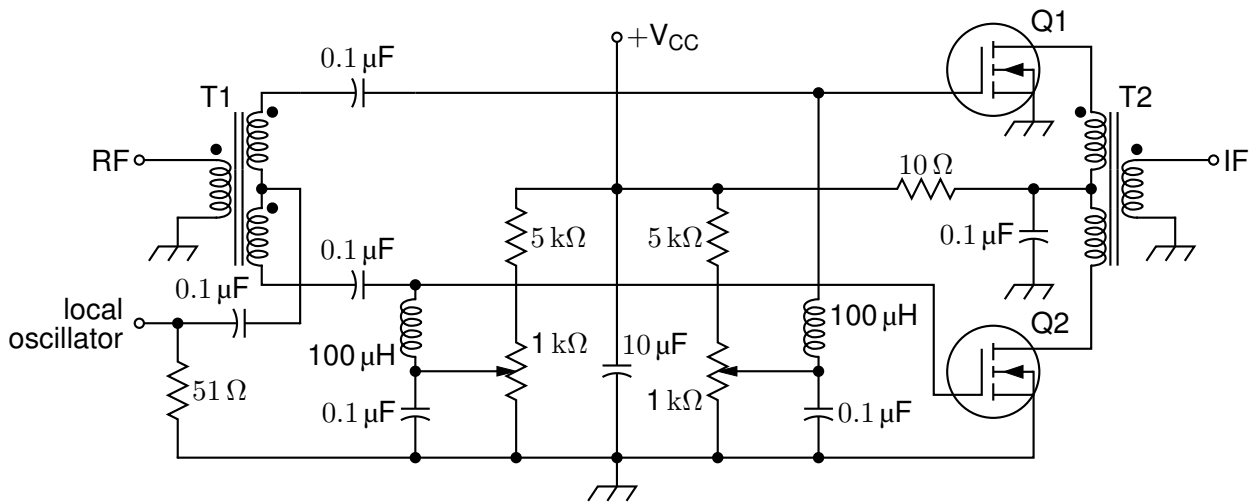


Figure 40: A balanced mixer, using mosfet and a custom transformer [Mixer.m4].

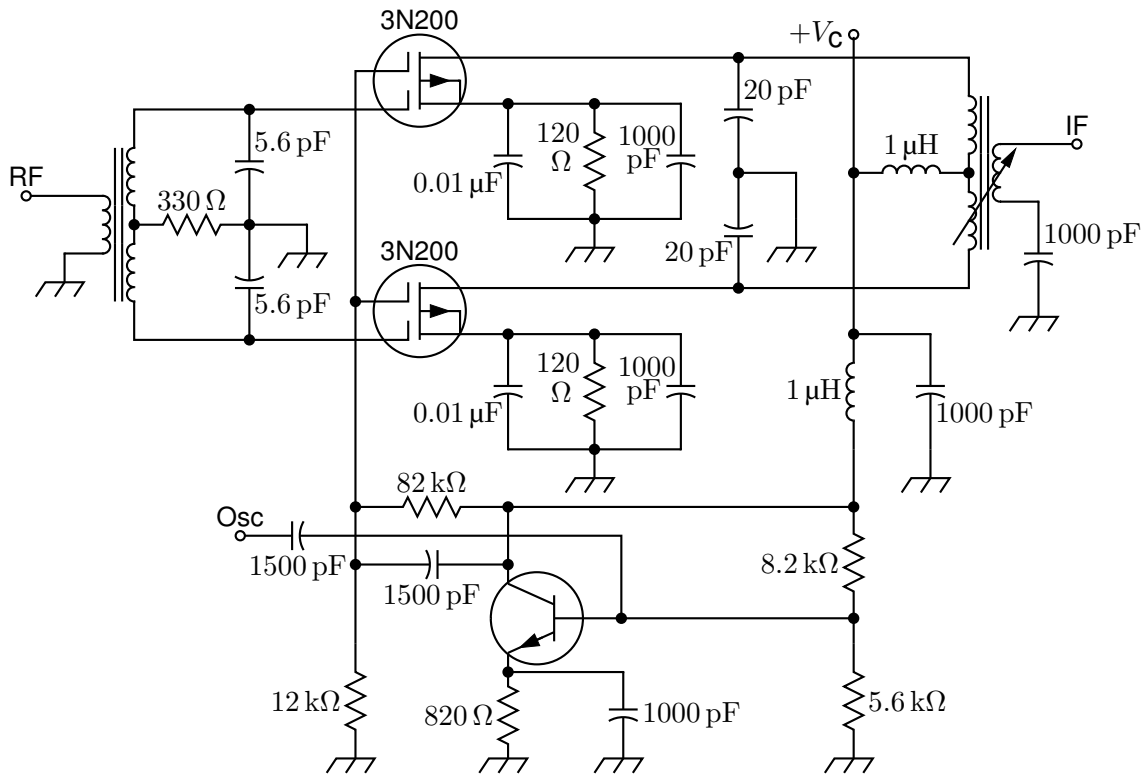


Figure 41: A push-pull mixer, showing FETs with multiple gates [PushPull.m4].

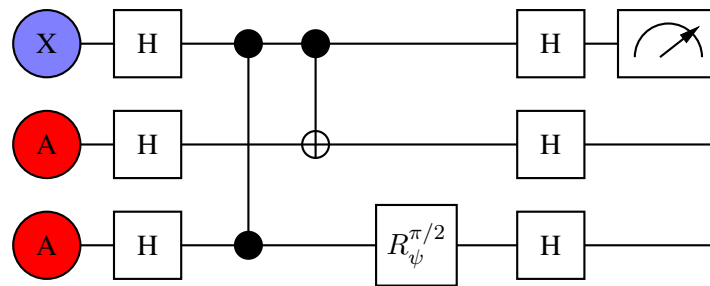


Figure 42: A quantum circuit [Quantum.m4].

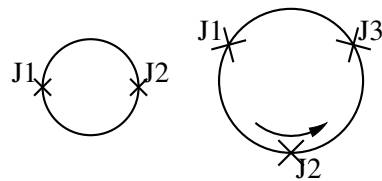


Figure 43: Superconducting quantum interface device (drawing direction down) [SQUID.m4].

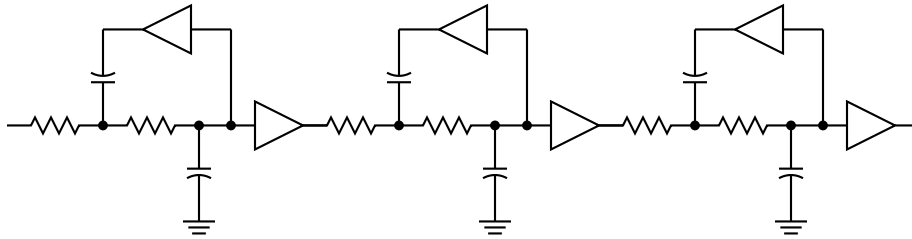


Figure 44: A six-pole filter [Sixpole.m4].

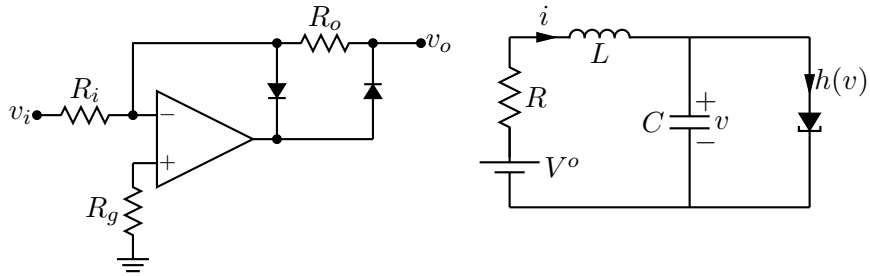


Figure 45: Precision half-wave rectifier and a tunnel diode circuit (illustrating opamp, diode, resistor, ground, and labels) [ex18.m4].

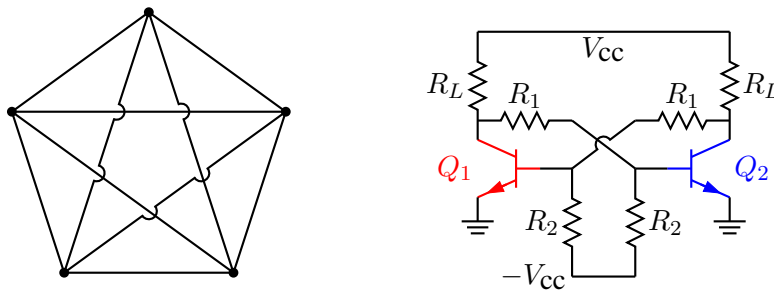


Figure 46: Non-planar graph and bistable circuit (illustrating the crossover macro and colored elements) [ex10.m4].

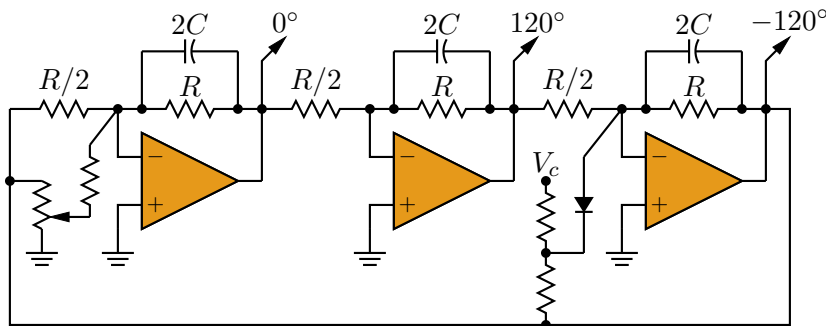


Figure 47: Three-phase oscillator [Three.m4].

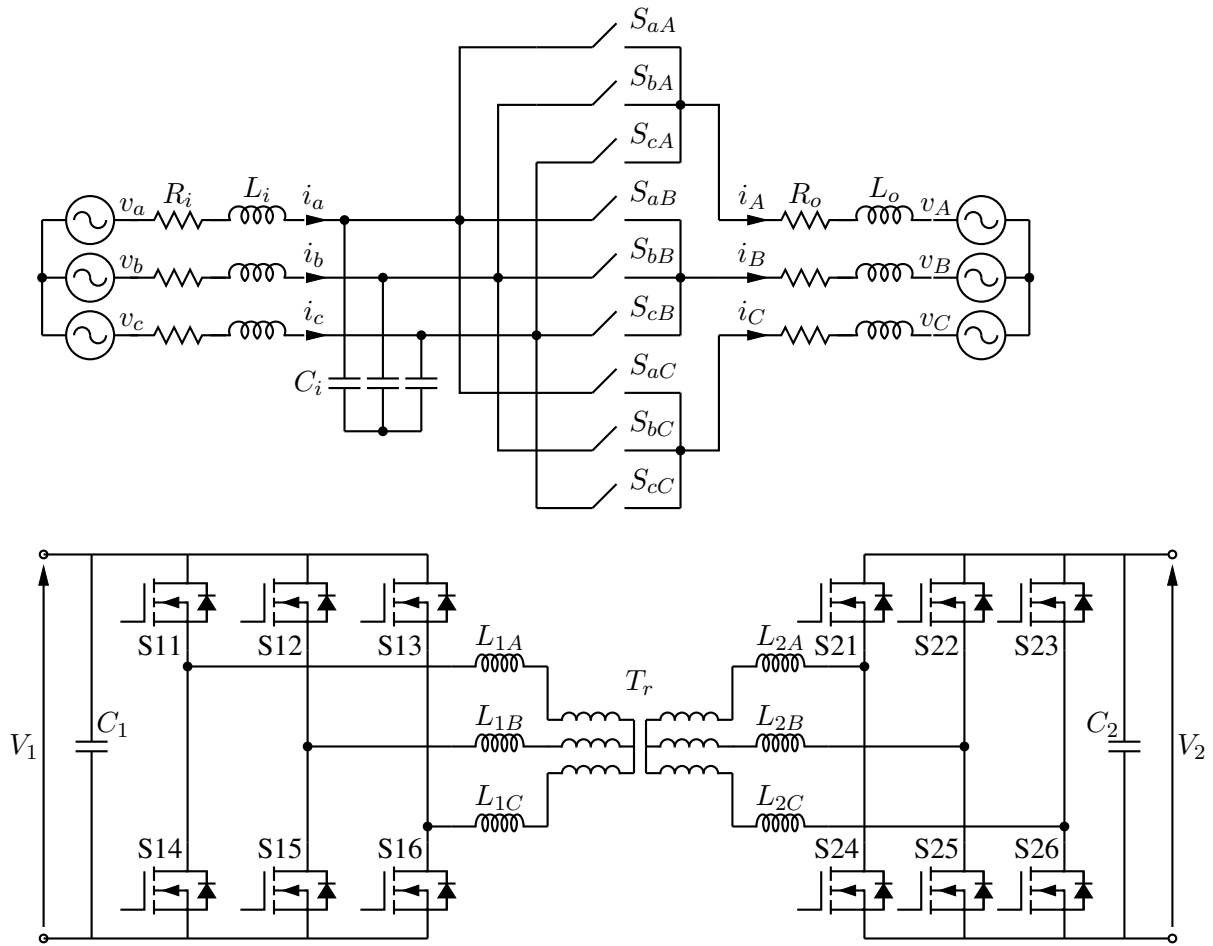


Figure 48: A three-phase switched AC-AC converter and a DC-DC converter [MC.m4].

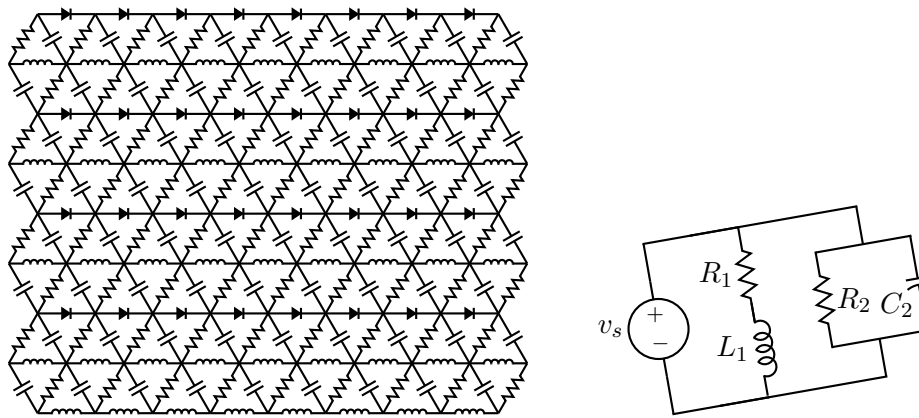


Figure 49: A repetitive network created by Pic looping and a skewed circuit used to test the macro parallel. [ex17.m4].

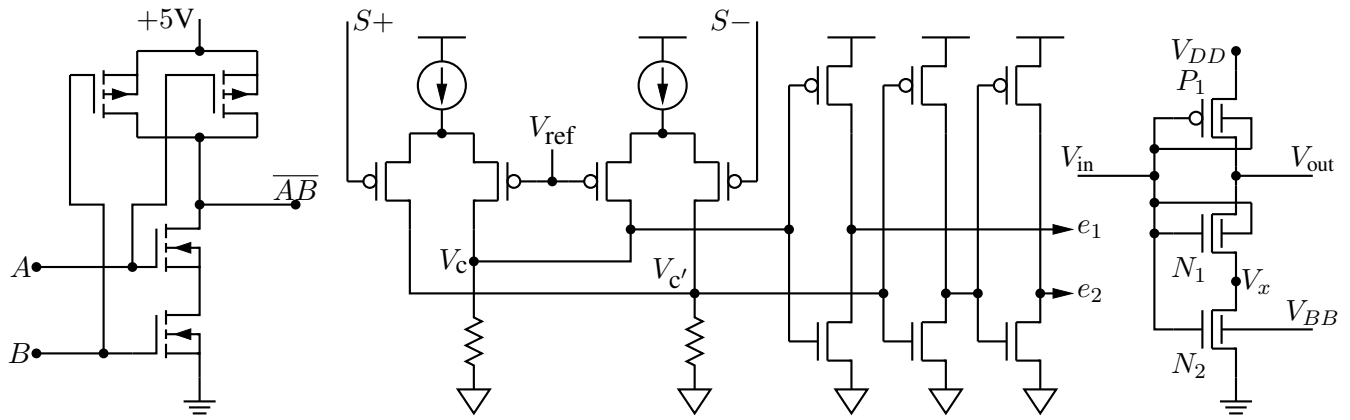


Figure 50: A CMOS NAND gate, a test circuit, and an X MOSFET example [ex12.m4].

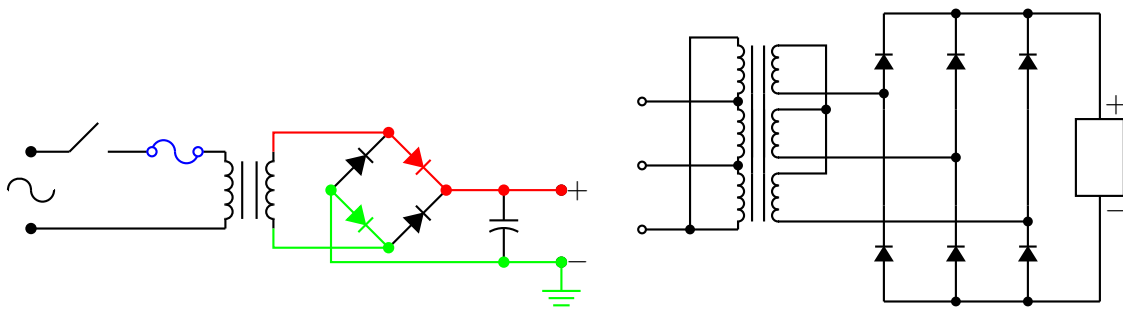


Figure 51: An elementary power supply circuit with colored elements, and a multiple-winding transformer with 3-phase rectifier [pwrsupply.m4].

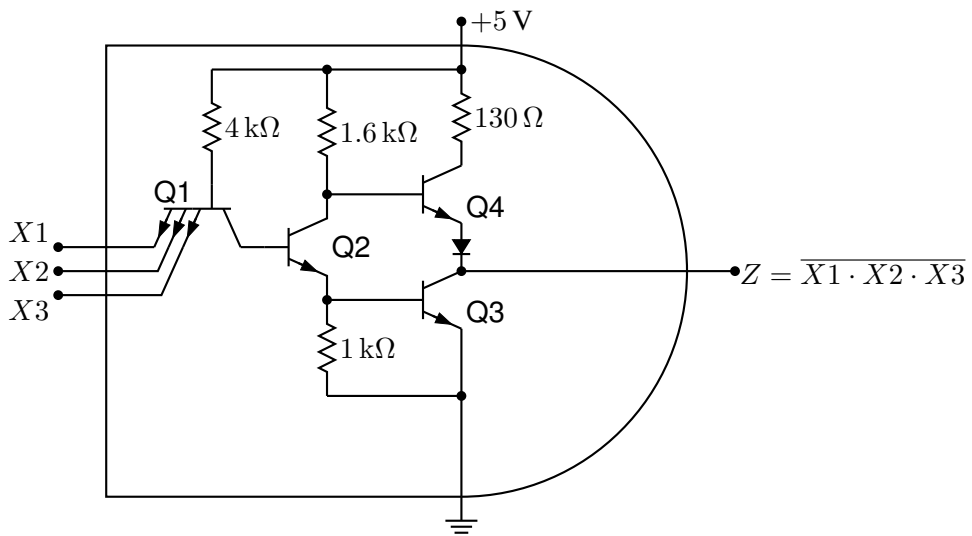


Figure 52: TTL NAND gate illustrating a transistor with multiple emitters [TTLnand.m4].



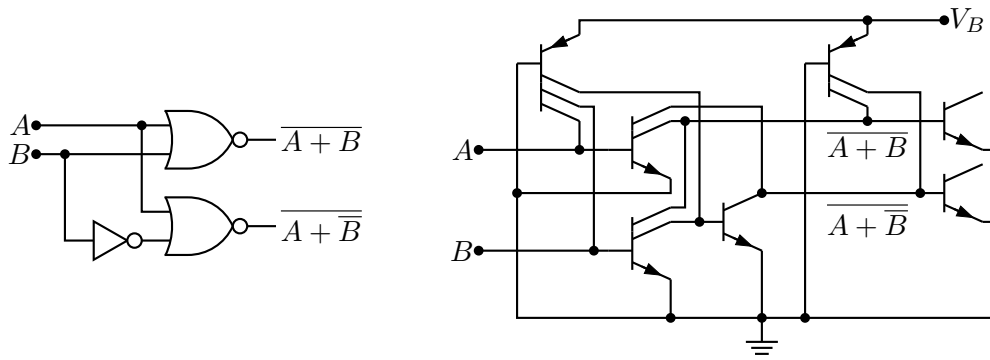


Figure 53: Gate circuit and equivalent embedded  $I^2L$  components illustrating multiple collectors [I2L.m4].

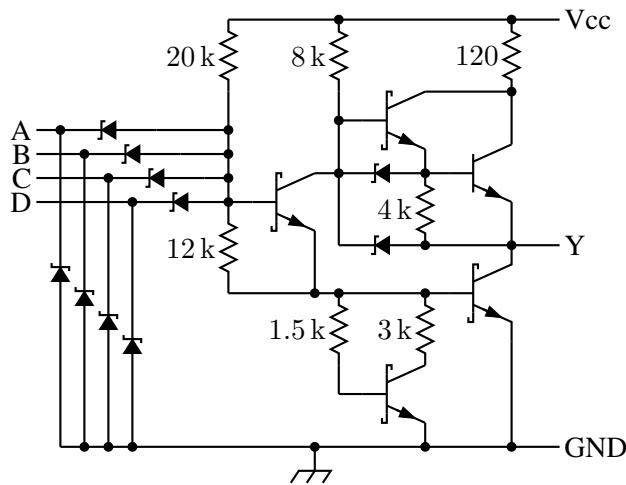


Figure 54: A 4-input NAND circuit illustrating the S (Schottky) option of bi.trans [Schottky.m4].

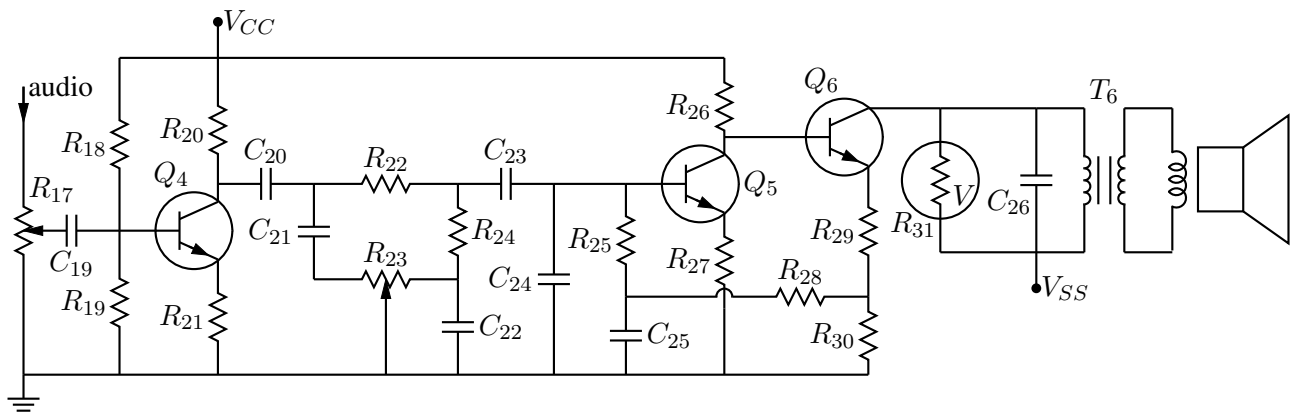


Figure 55: Transistor radio audio chain [ex11.m4].

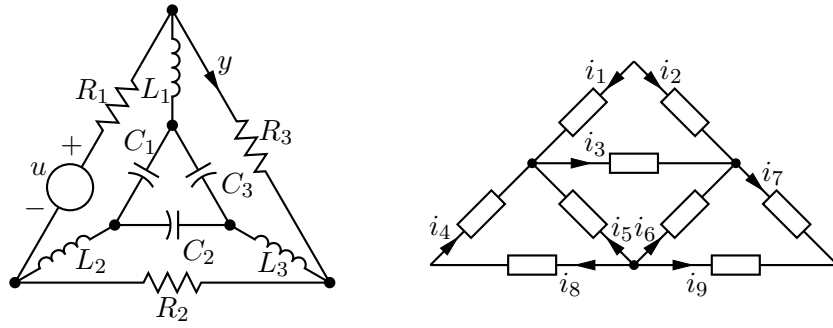


Figure 56: Labels on non-manhattan elements [ex04.m4].

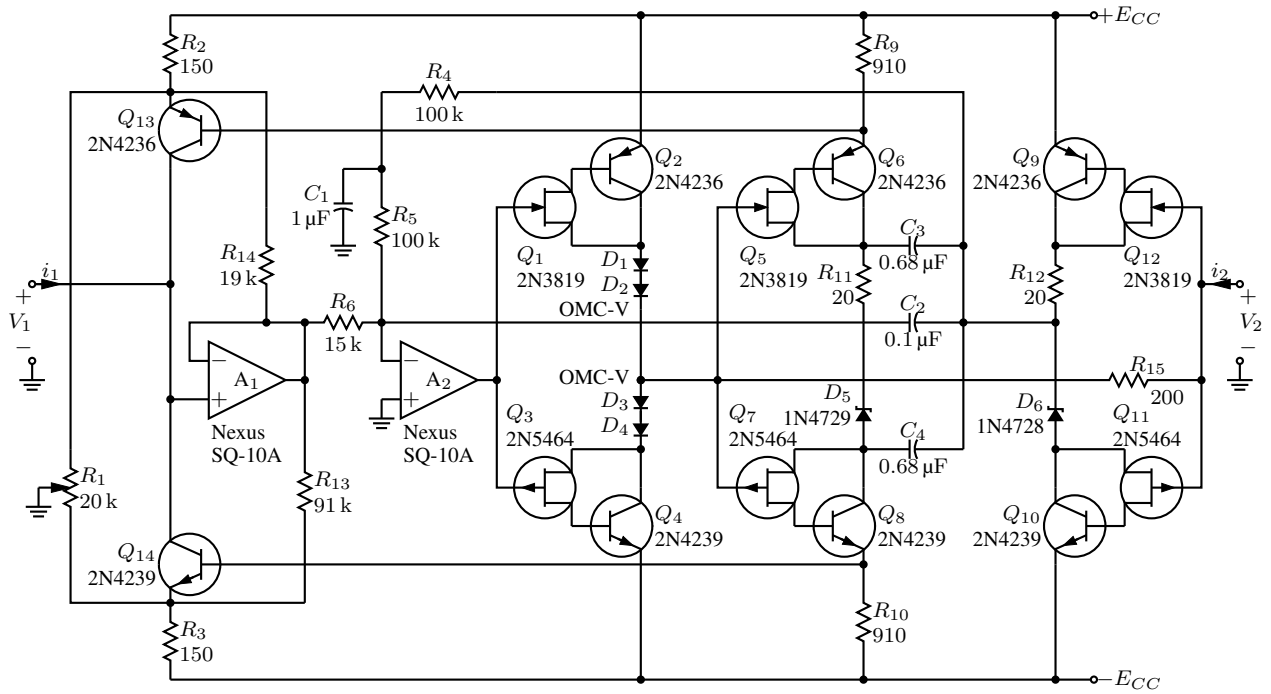


Figure 57: Realization of a controlled source (illustrating stacked element labels) [Csource.m4].

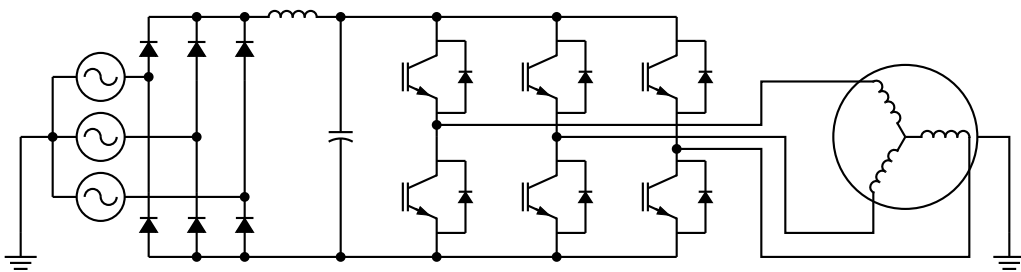


Figure 58: Synchronous machine driven by variable-speed drive and rectifier [Drive.m4].

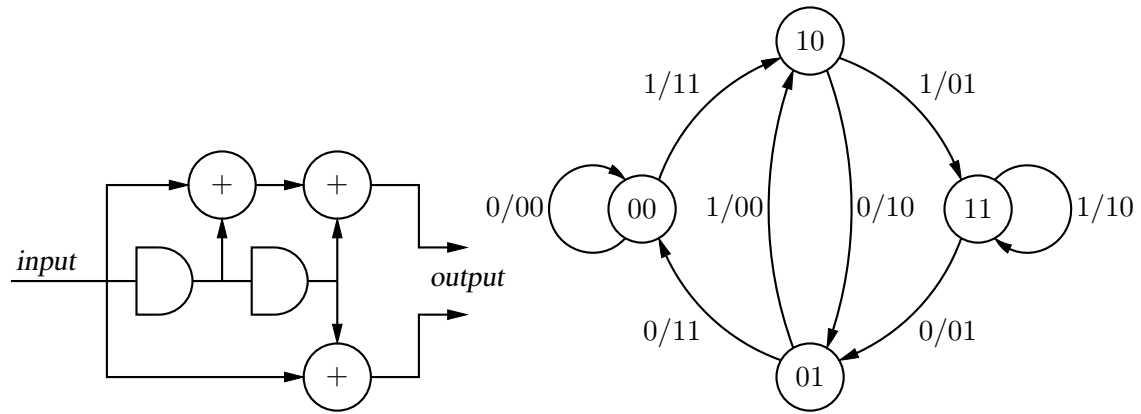


Figure 59: A rate 1/2 binary convolutional coder and its state diagram [ex16.m4].

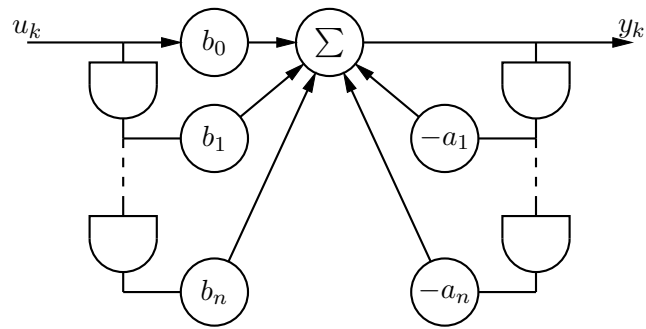


Figure 60: Digital filter [ex03.m4].

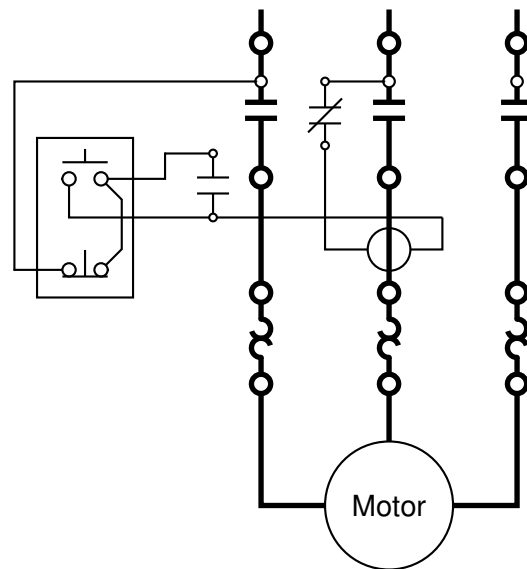


Figure 61: Motor control connections [MotorControl.m4].

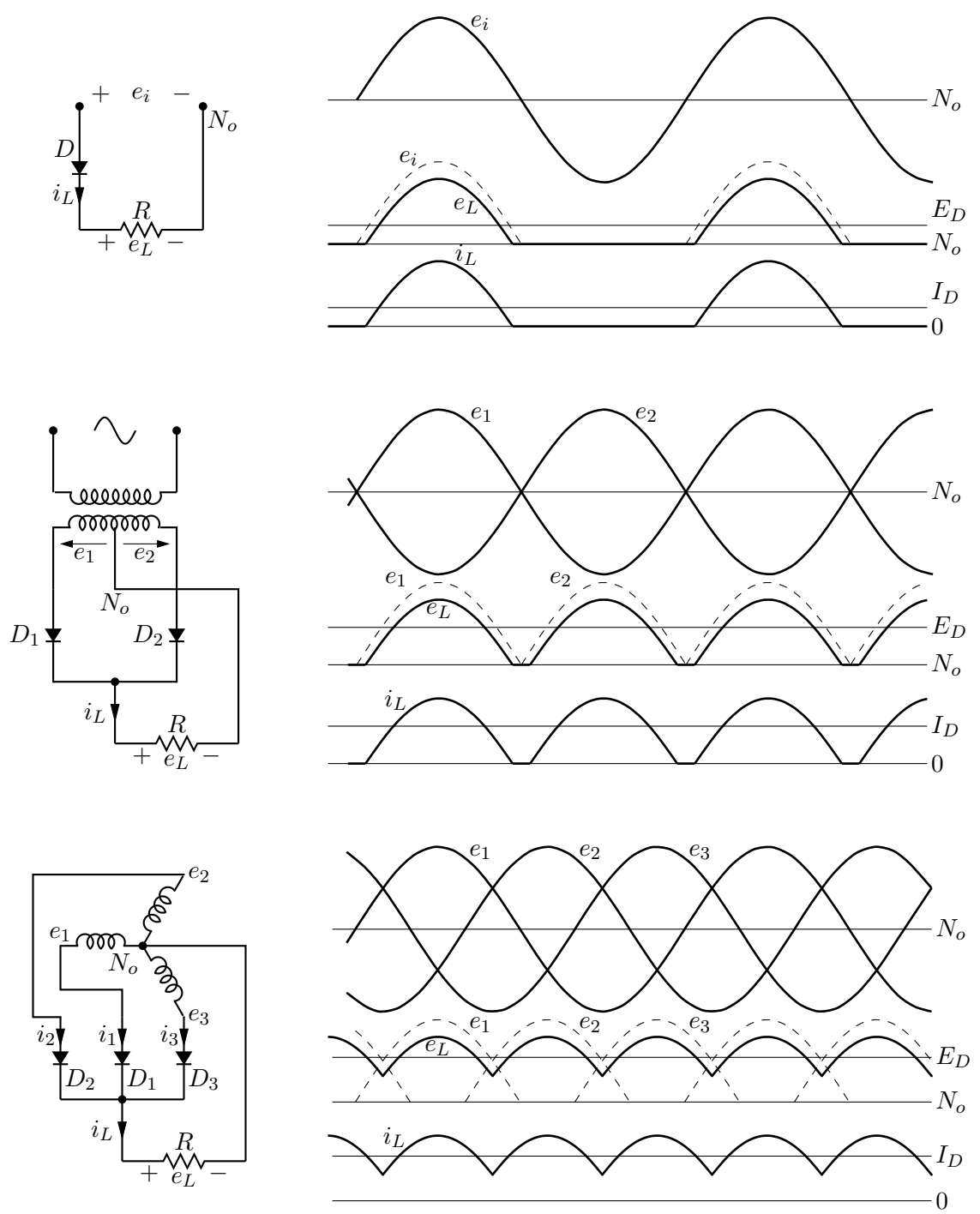


Figure 62: Rectifier circuits and waveforms [Rectifiers.m4].

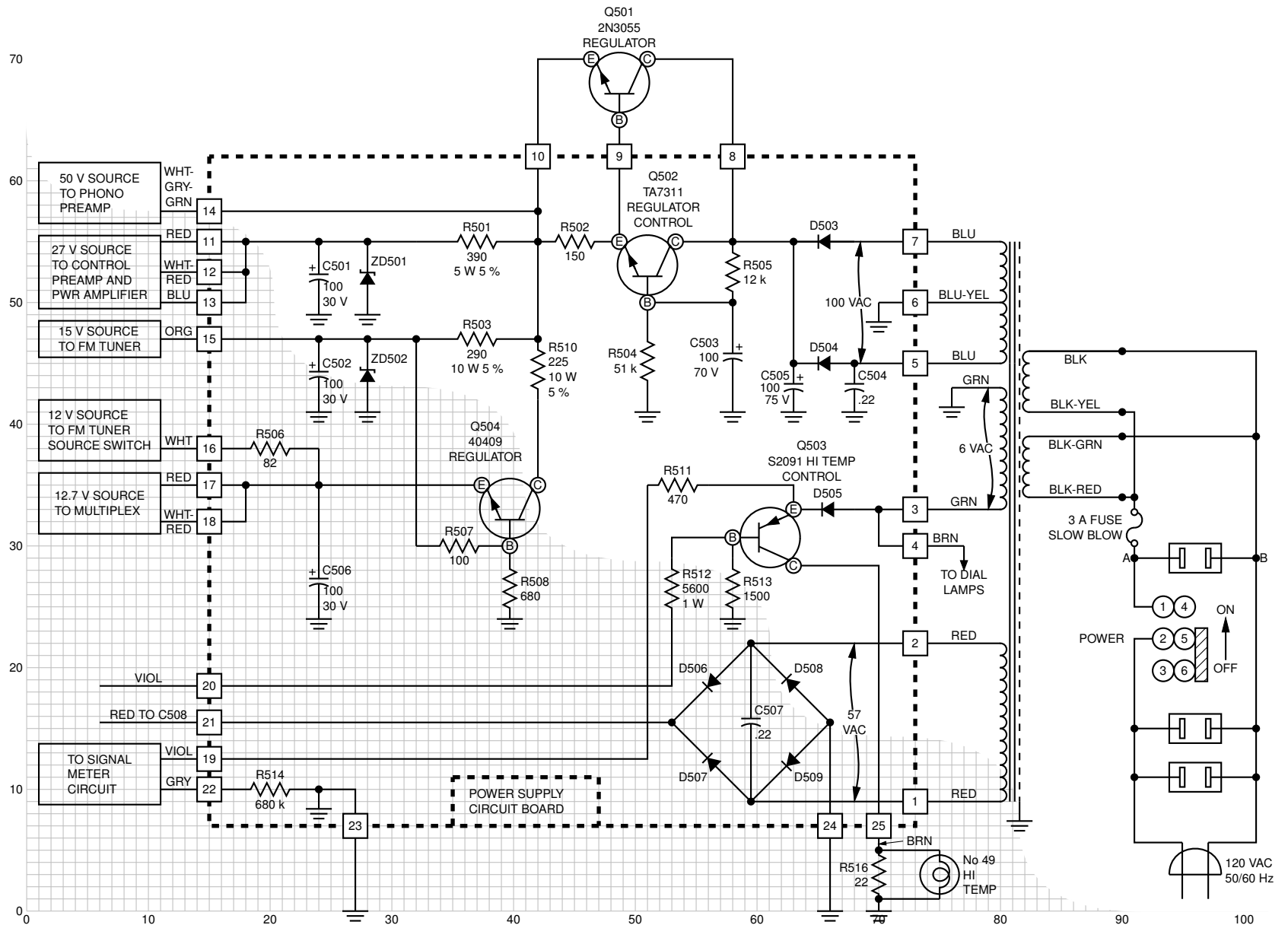


Figure 63: The power supply of a Heathkit AR-15 (Now, *that* was a receiver!) with custom transformer and other elements, drawn on a grid (partially shown) to aid in placement [Heathkit.m4].

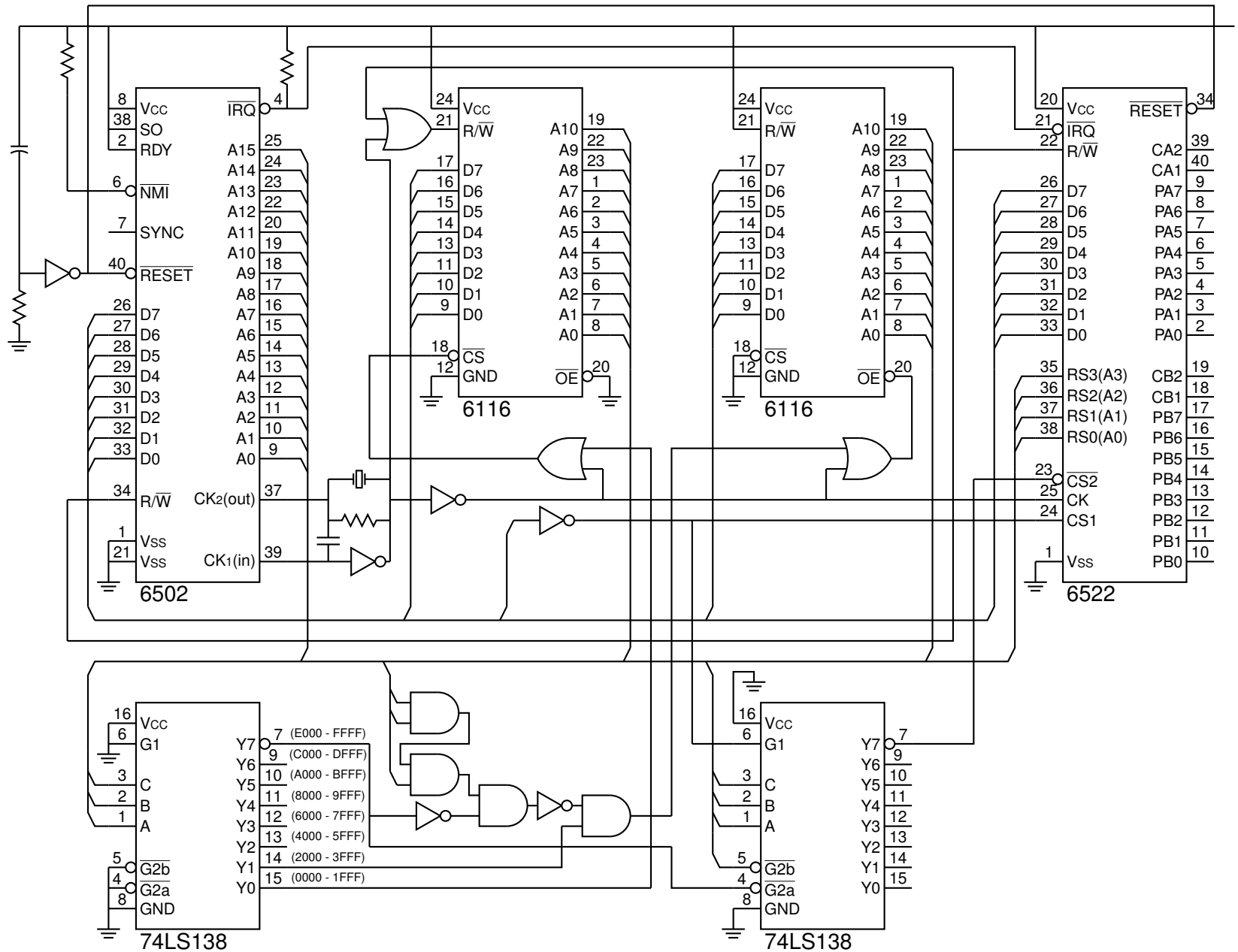


Figure 64: A digital circuit of moderate size, redrawn from M. P. Maclenan and G. M. Burns, "An Approach to Drawing Circuit Diagrams for Text Books," Tugboat (12)1, March 1991, pp. 66-69 [lcct.m4].



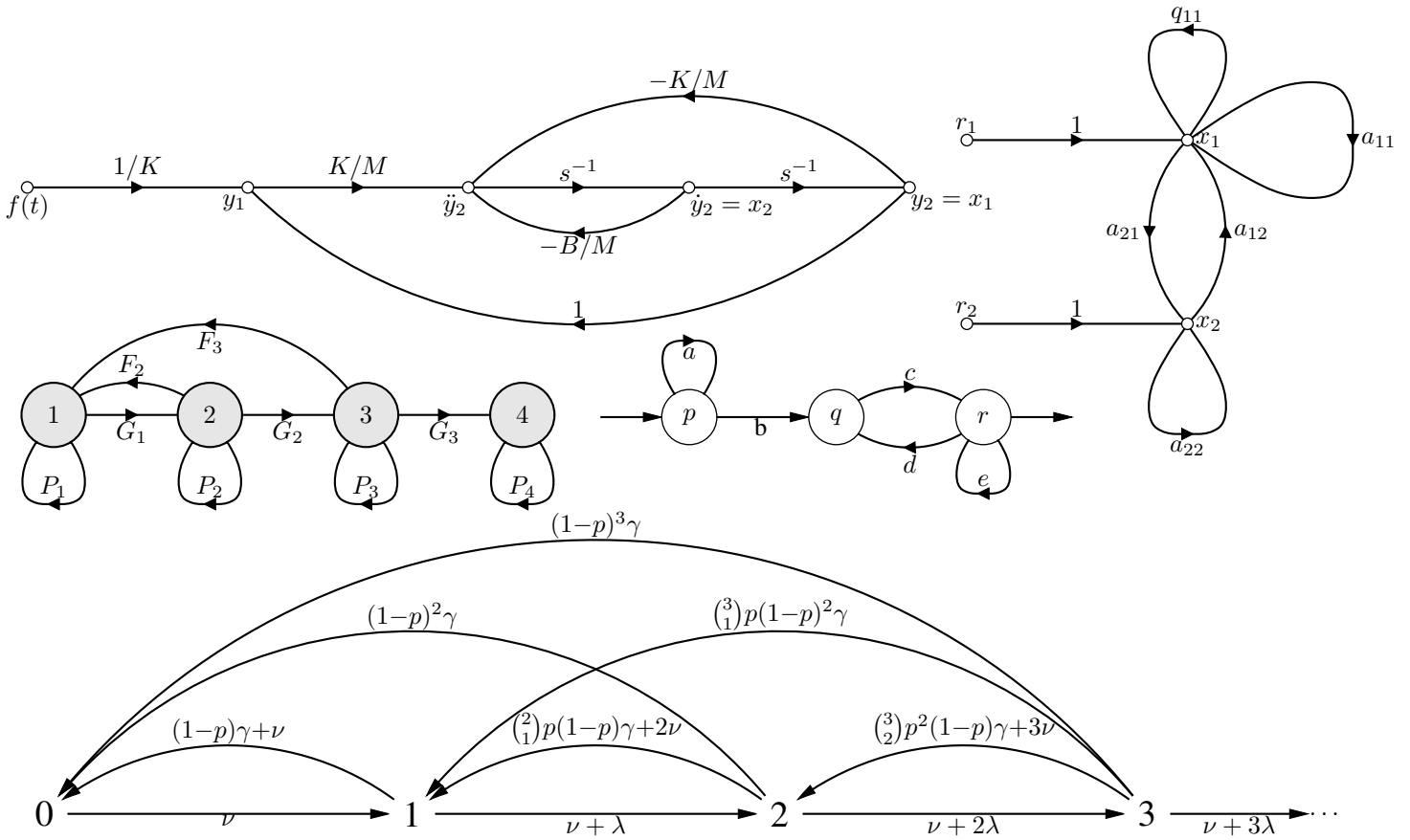


Figure 66: Signal-flow graphs [sfg.m4].

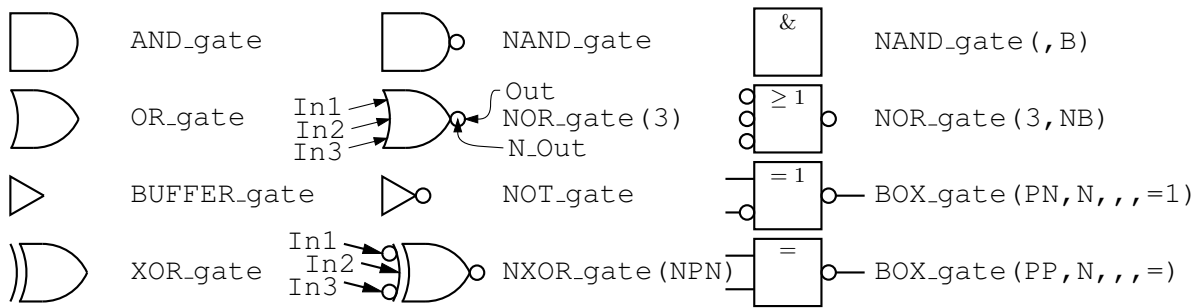


Figure 67: Basic logic gates [Logic.m4].



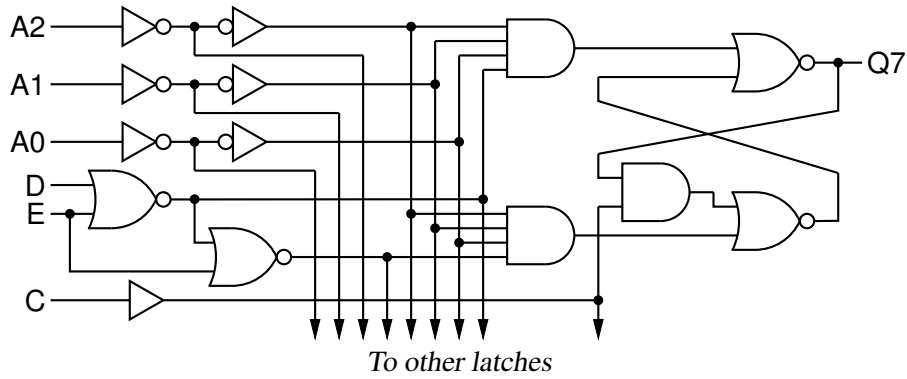


Figure 68: General-purpose latch: a small logic circuit [ex08.m4].

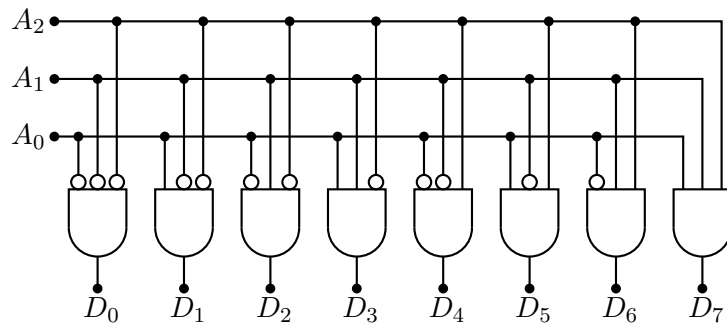


Figure 69: Decoder logic, constructed using the for\_macro [Decoder.m4].

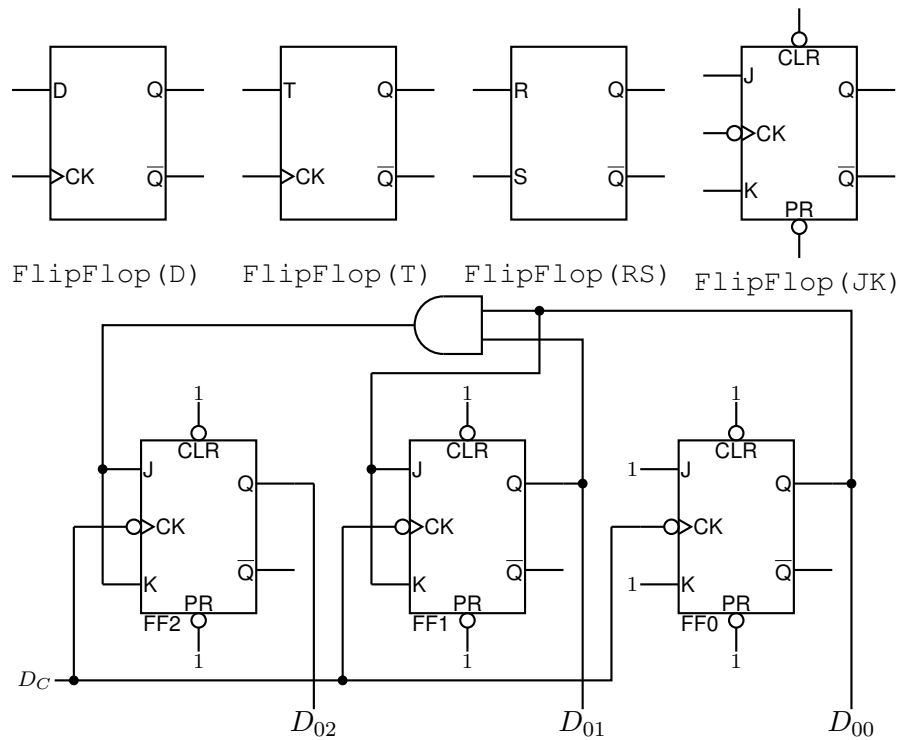


Figure 70: Some flip-flops [ex21.m4].

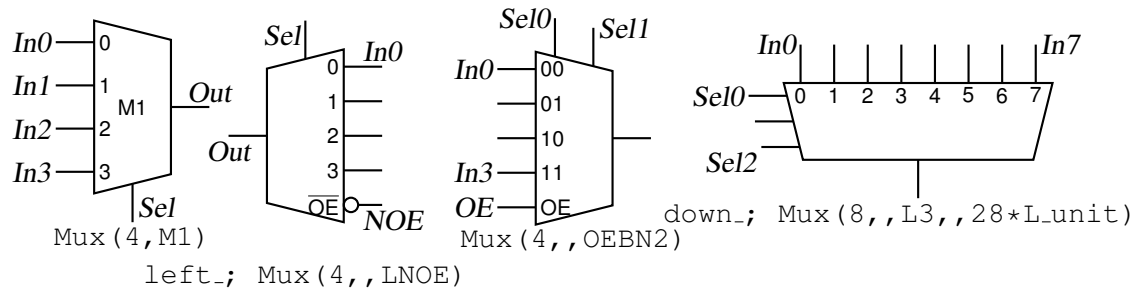


Figure 71: Multiplexer [Multiplexer.m4].

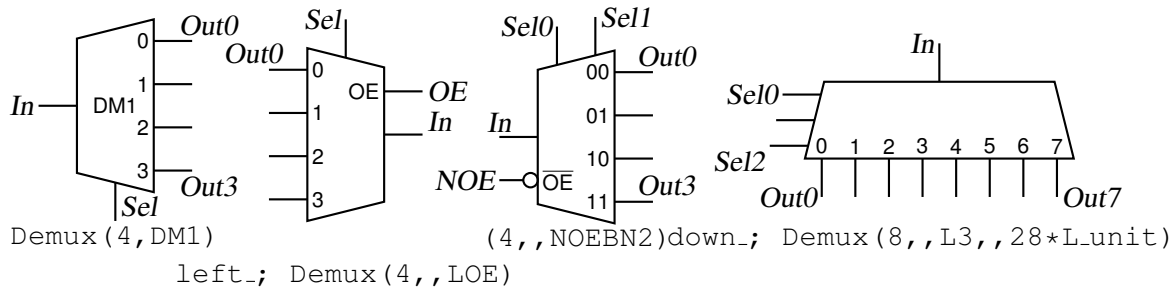


Figure 72: Demultiplexer [Demultiplexer.m4].

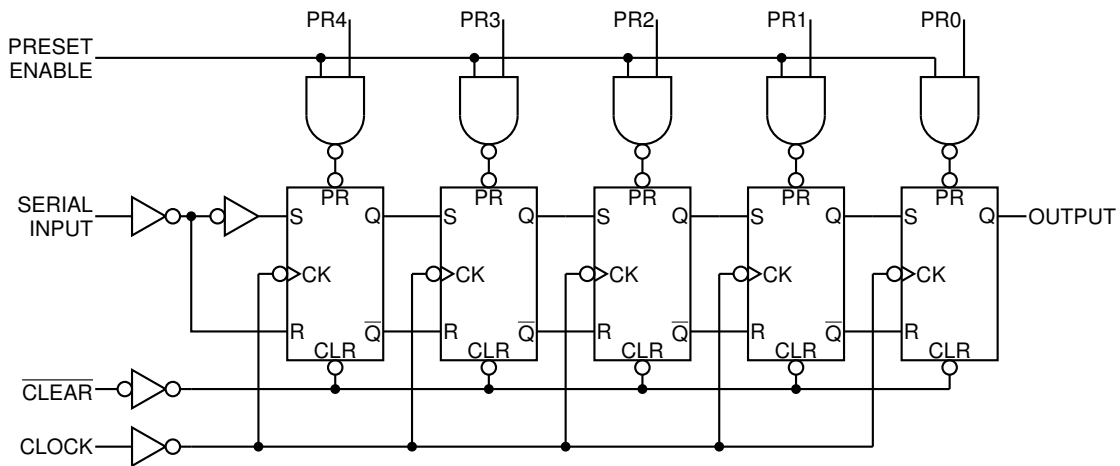


Figure 73: A 5-bit shift register drawn using a custom flip-flop [ShiftR.m4].

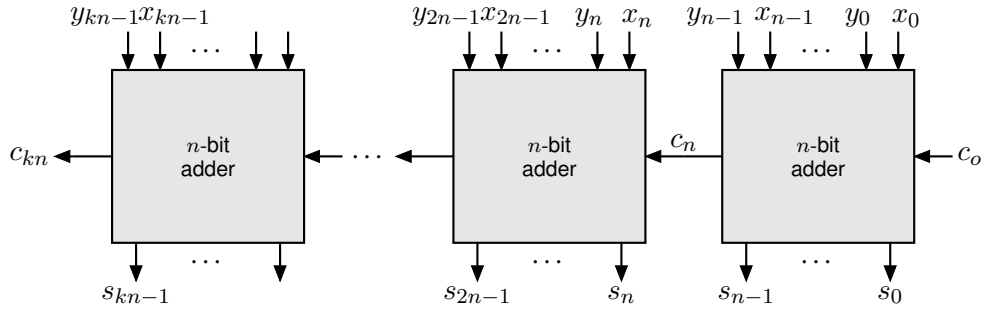
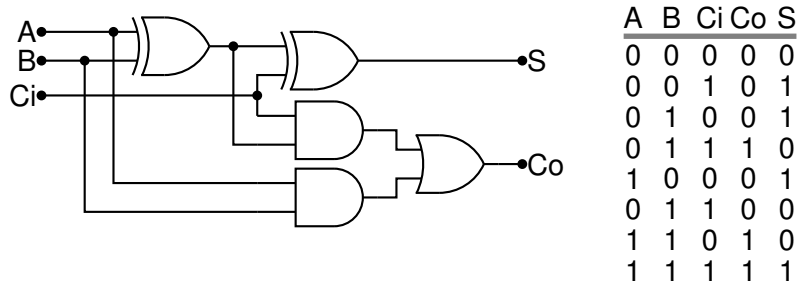
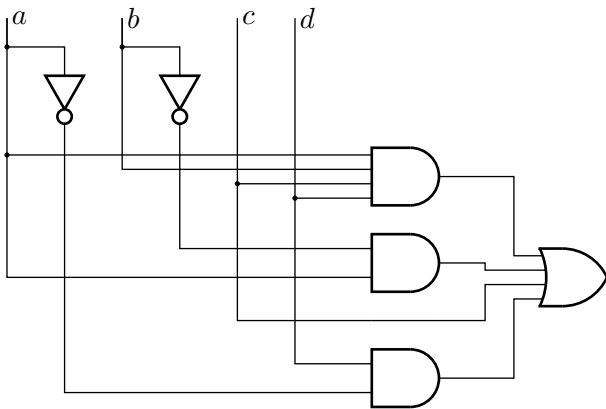
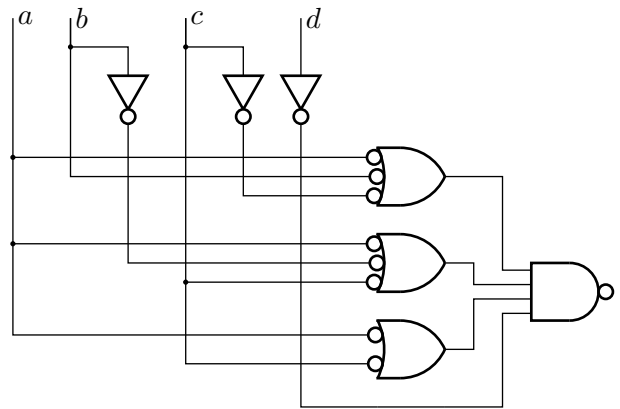


Figure 74: A full adder and a cascade of  $n$ -bit adders [Adder.m4].



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



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

Figure 75: A way of automatically drawing two-layer logic diagrams [CanLogic.m4].

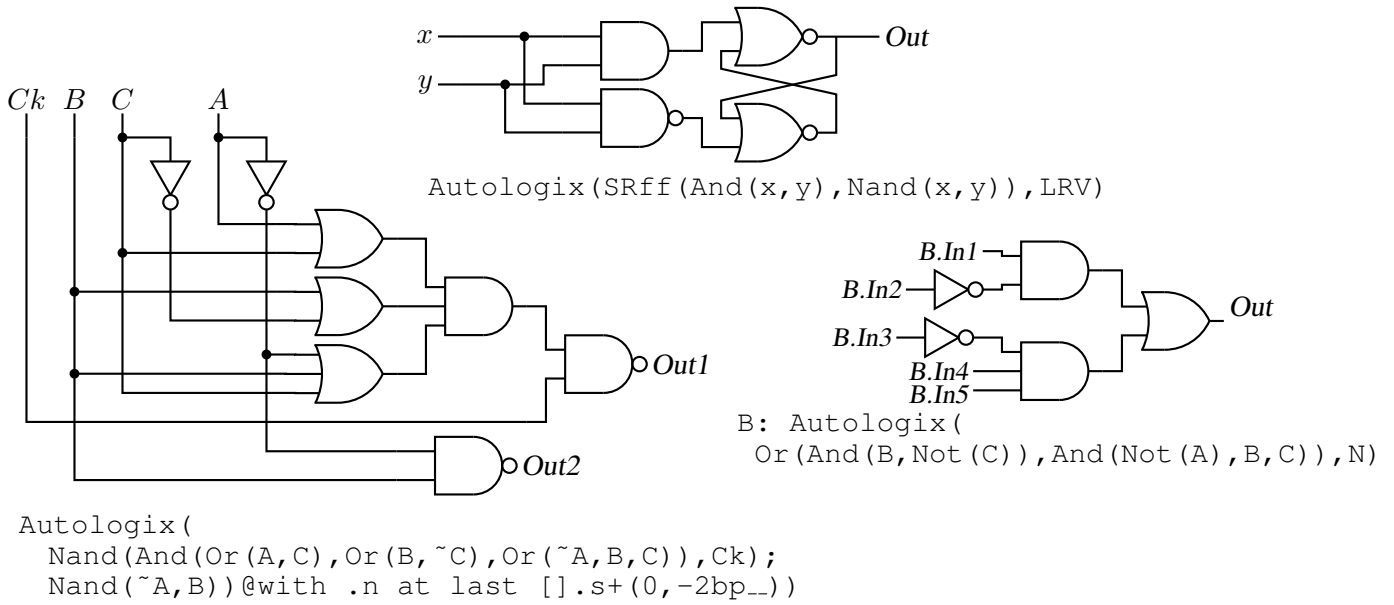
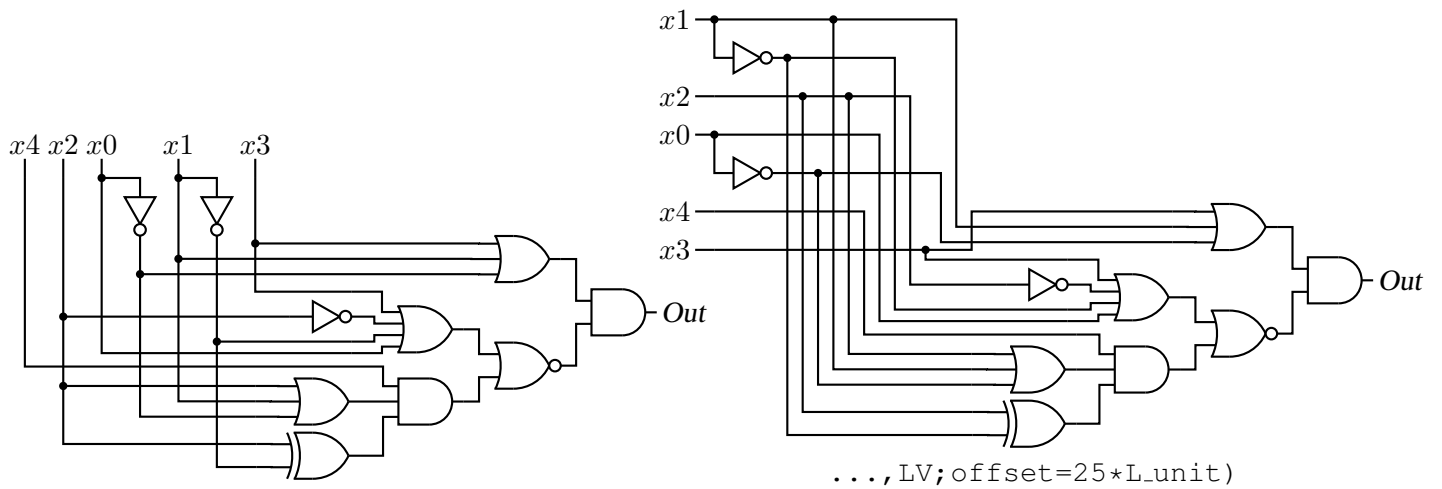


Figure 76: The `Autologix (Boolean expression; Boolean expression... , options)` macro automatically draws Boolean expressions in function notation. The function tree is drawn, then a row or column of inputs, then the connections. The default result is on the left, a custom element at the top, and a 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))))))
```

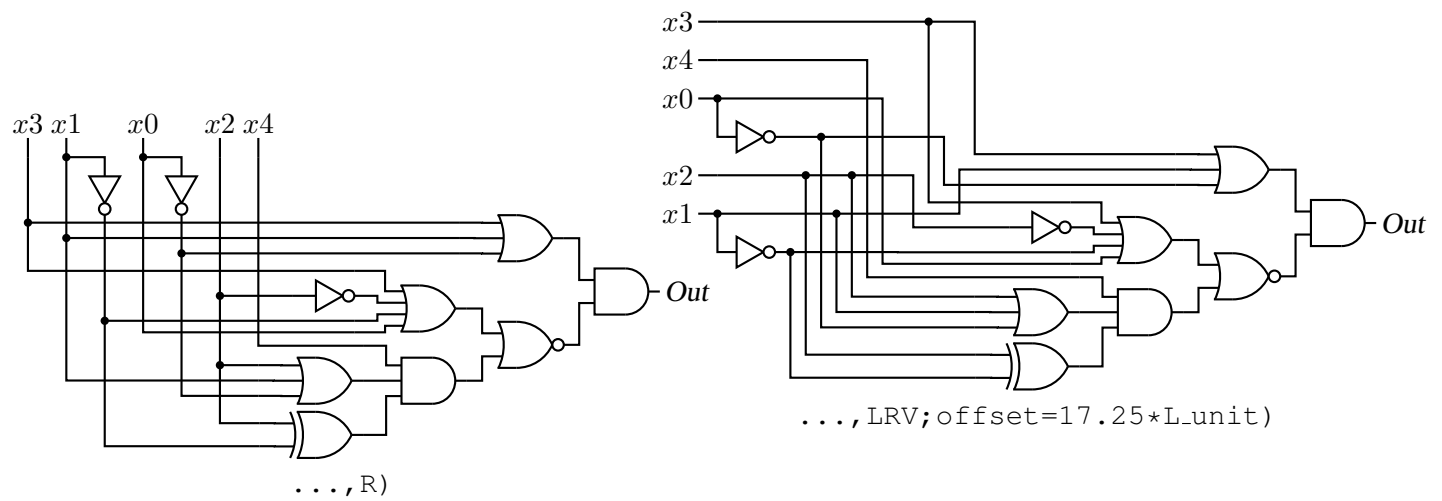


Figure 77: The Autologix macro can draw inputs on the left but the added drawing complexity may require hand tuning with second-argument options: L puts the inputs on the left, R reverses their order, V scans the input arguments in reverse order, and offset=value displaces the array of inputs [ABlogix.m4].

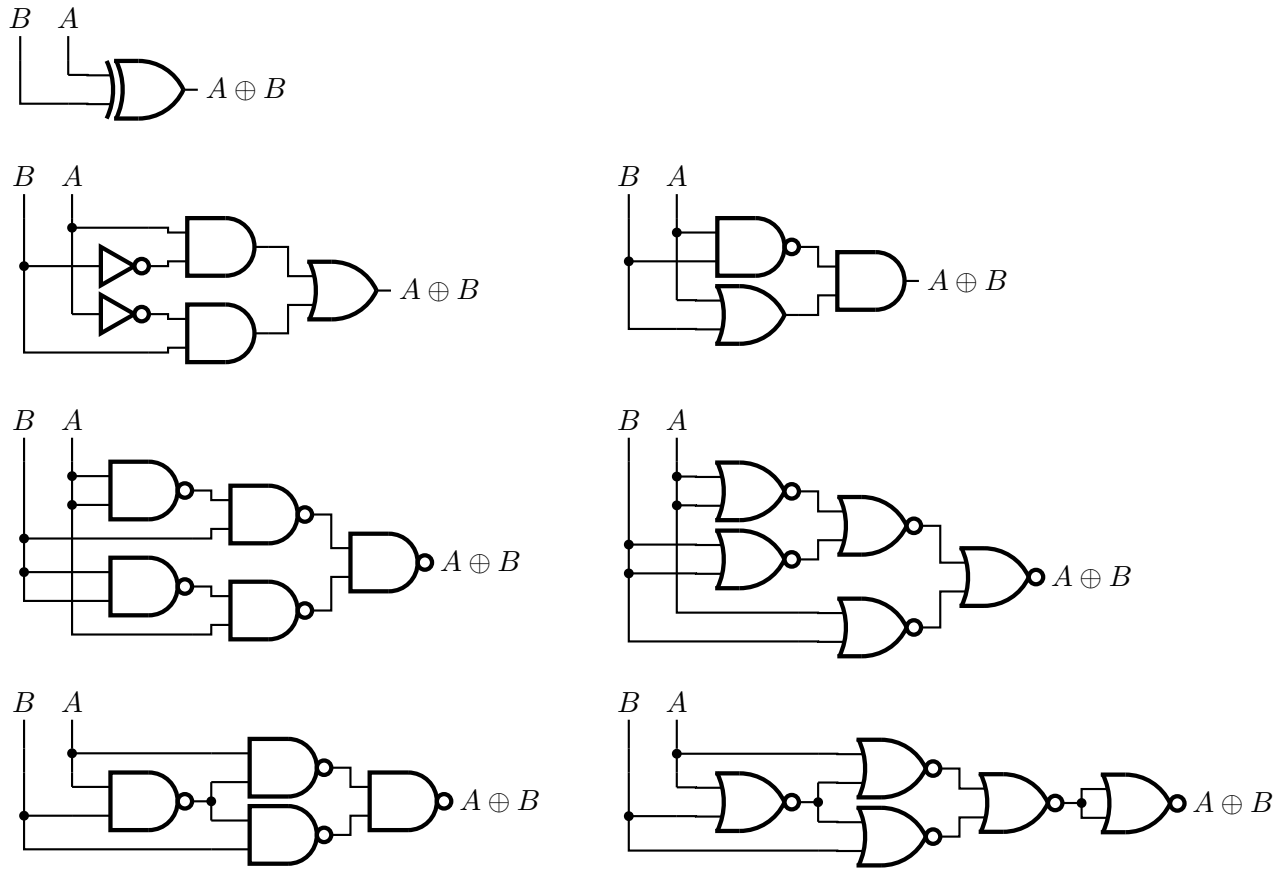


Figure 78: Realizations of the XOR function using Autologix [XOR.m4].

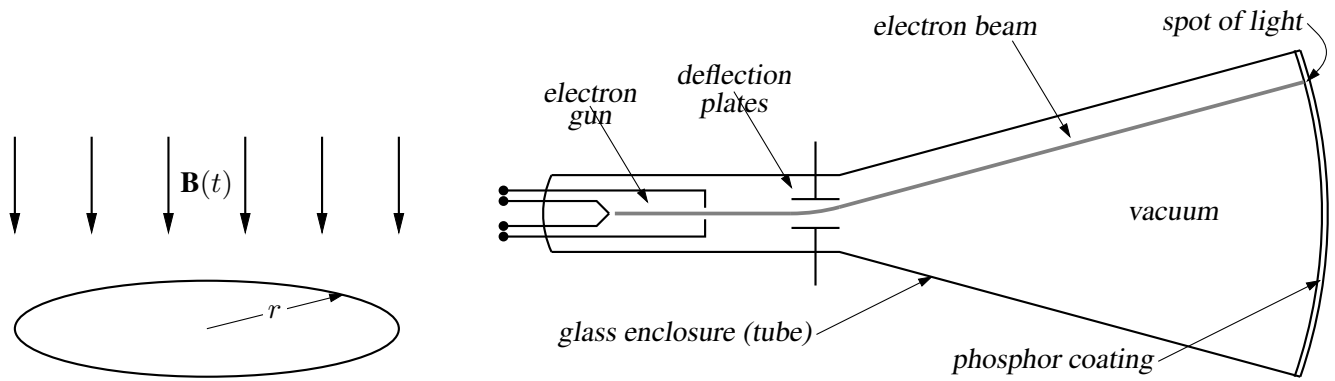
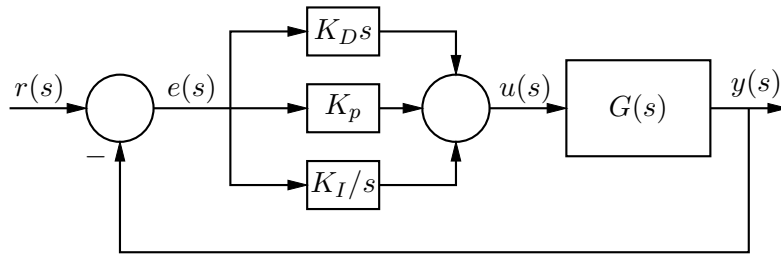
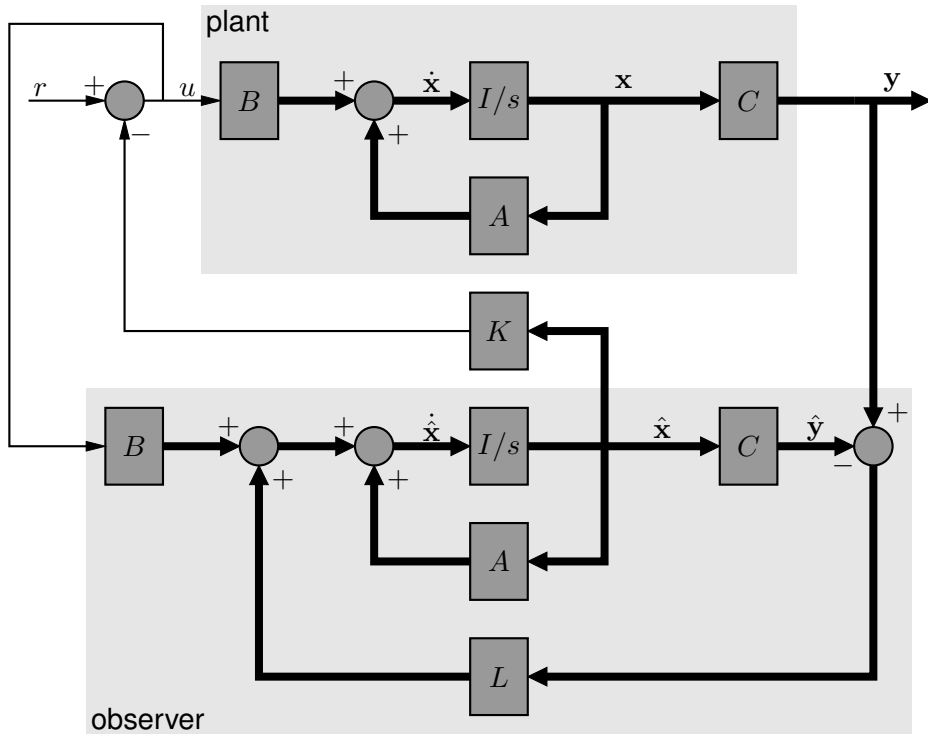


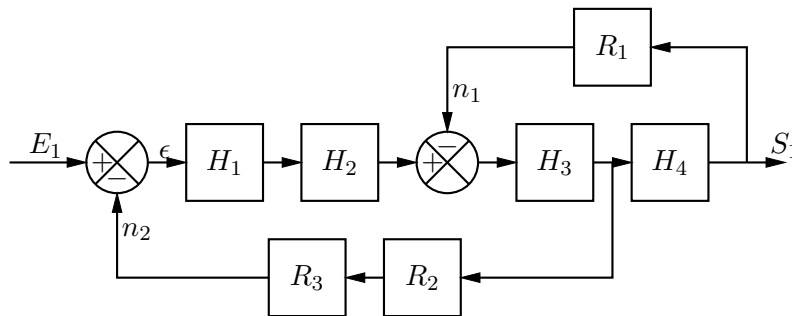
Figure 79: Line diagrams [ex00.m4].



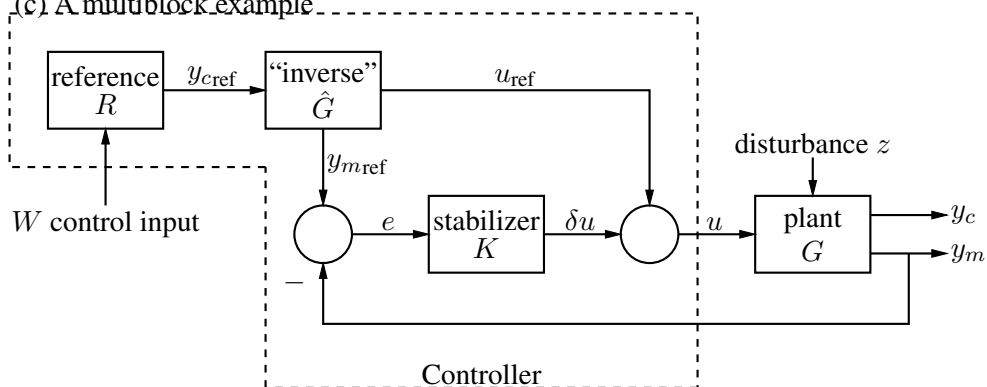
(a) *PID* control



(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)

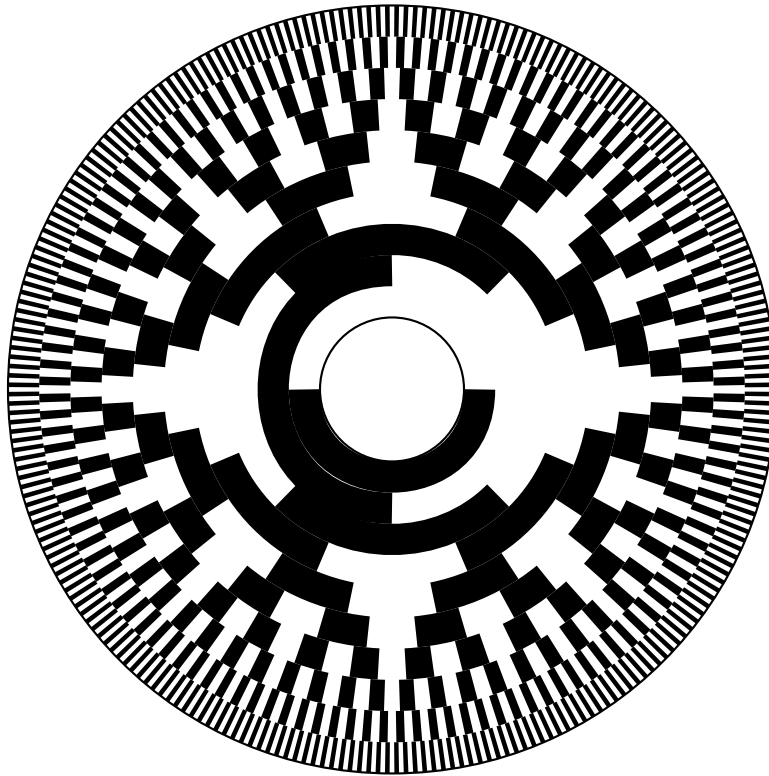


Figure 81: Gray code 10-bit encoder disk pattern [GrayCode.m4].

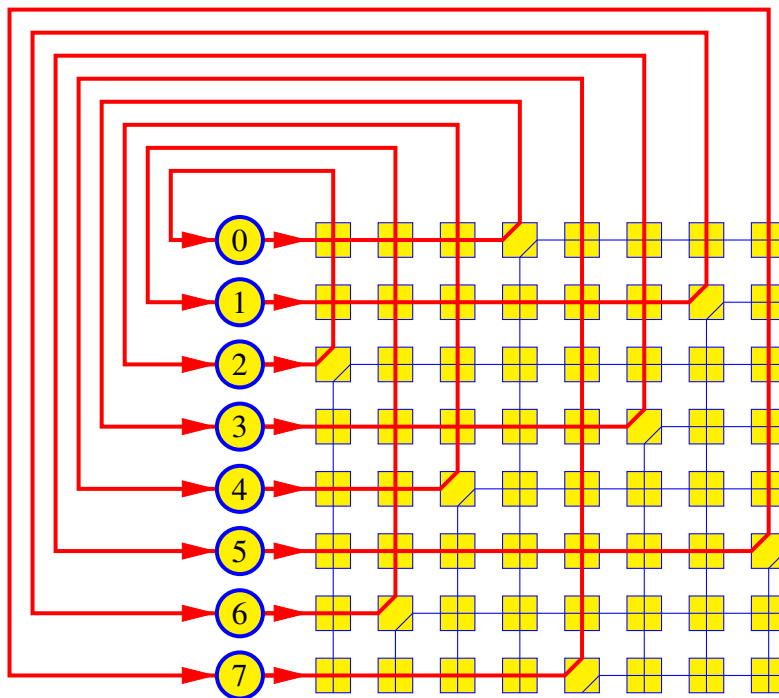


Figure 82: A crossbar switch [Crossbar.m4].



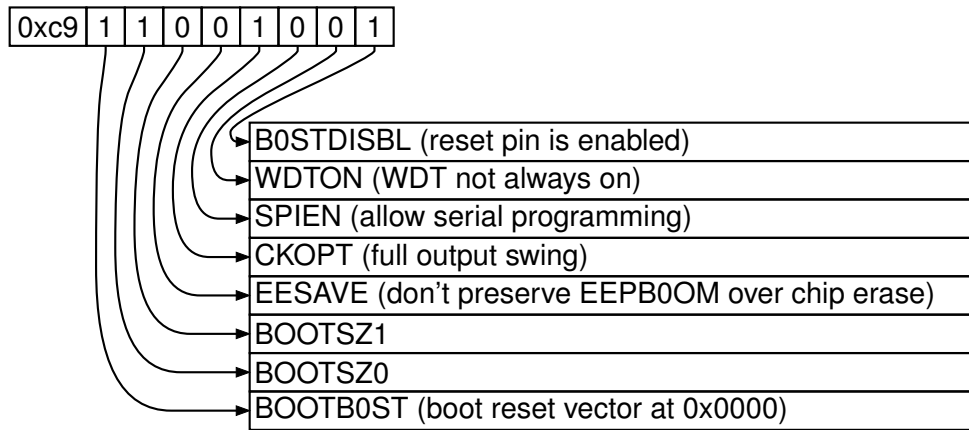


Figure 83: Elementary splines [Byte.m4].

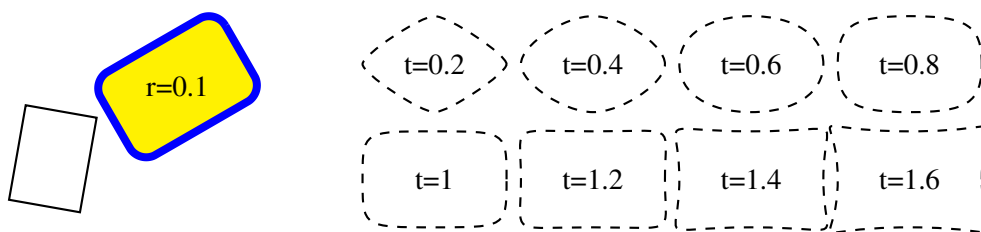


Figure 84: The macro `rotbox(wid,ht,type,[r|t=val])` draws a box in the current direction [Rotbox.m4].

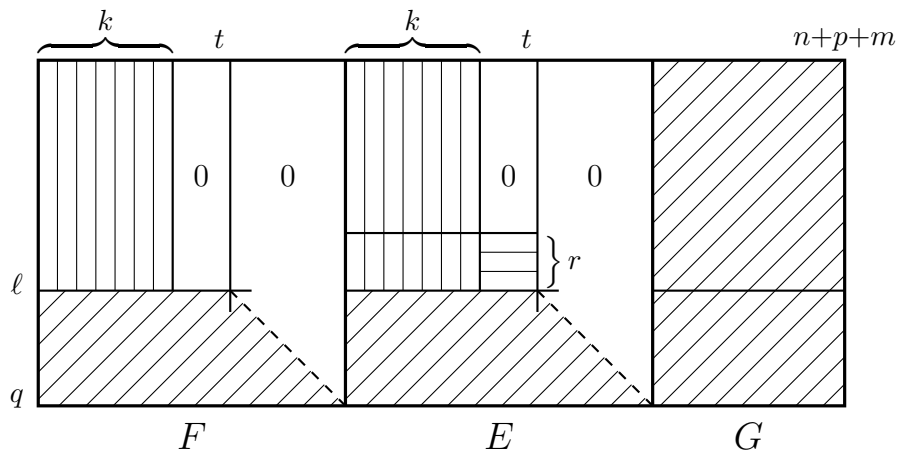
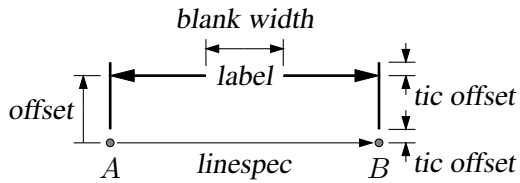
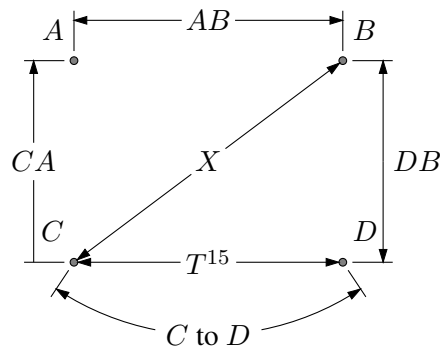
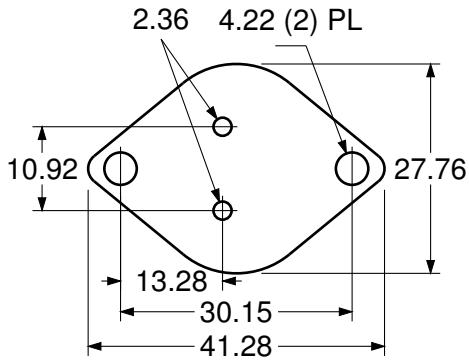


Figure 85: Crosshatching by `for` loops [ex06.m4].



```

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($T^{15}$,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 86: 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].

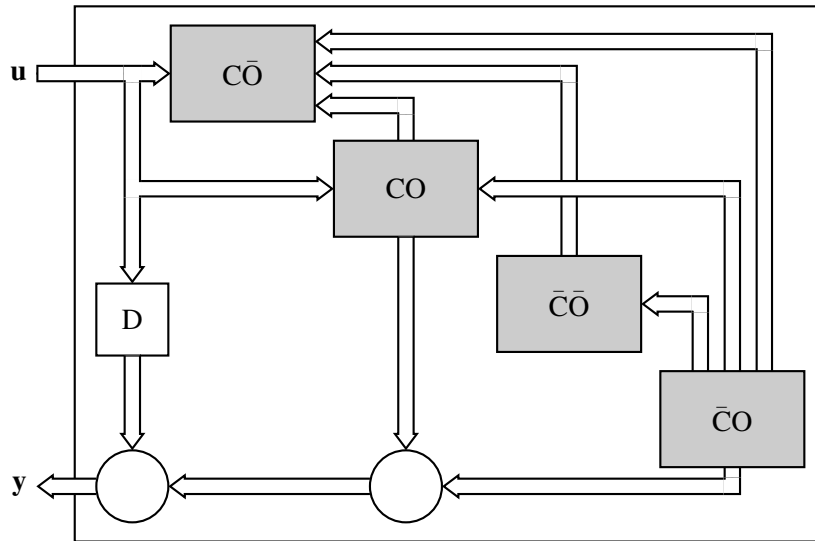


Figure 87: Use of `darrow` [ex05.m4].

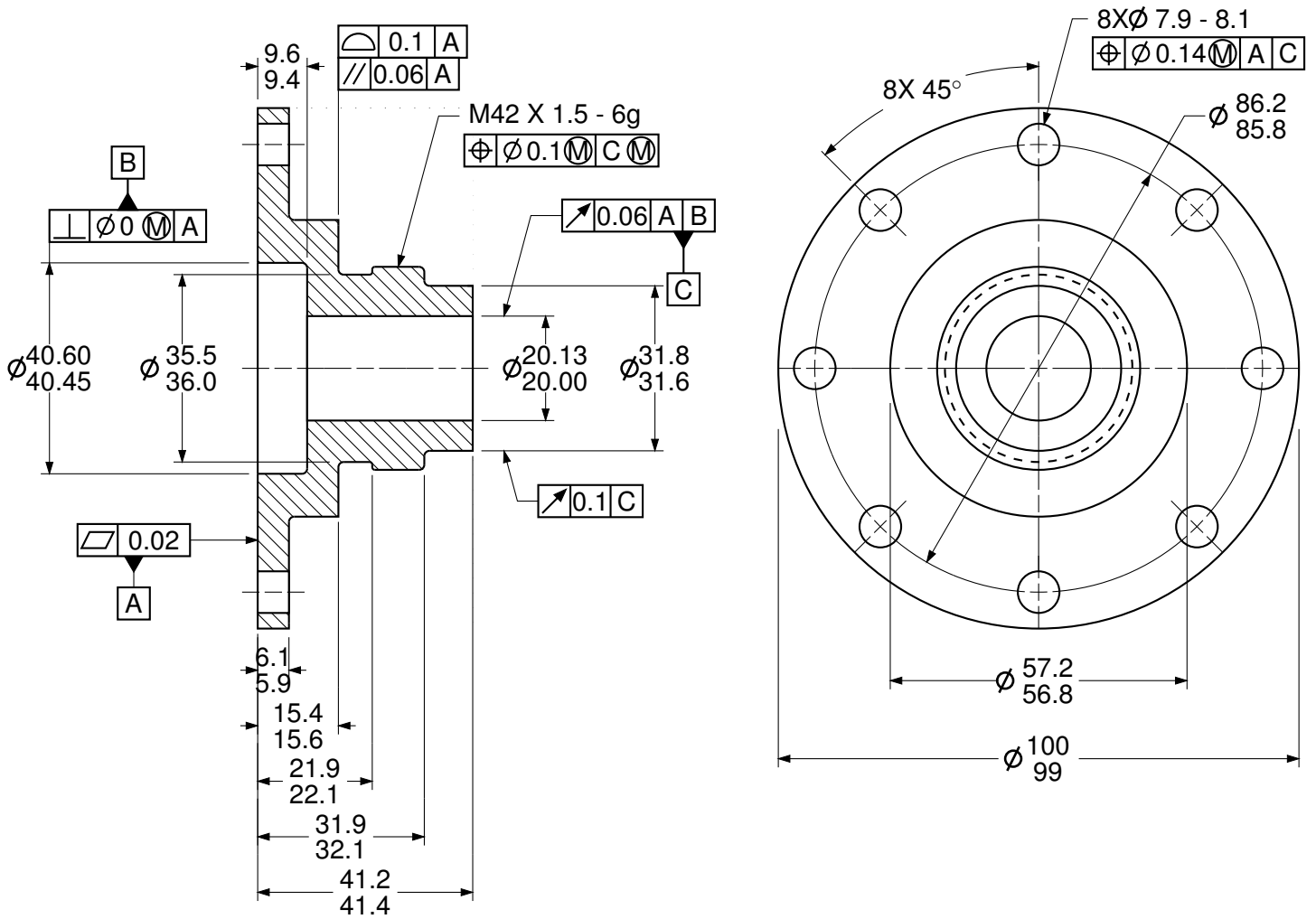


Figure 88: Dimensioning with tolerances [Plate.m4].

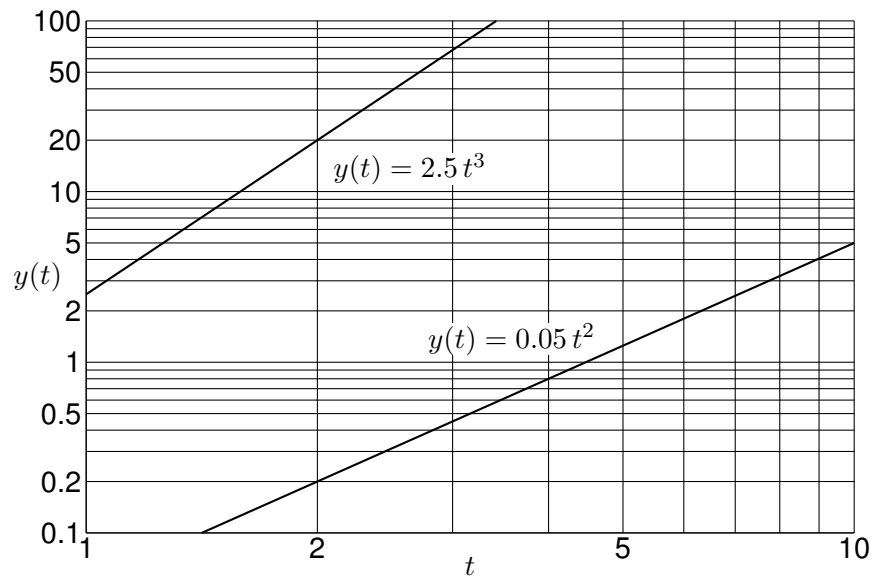


Figure 89: A graph drawn using the pic language [Loglog.m4].

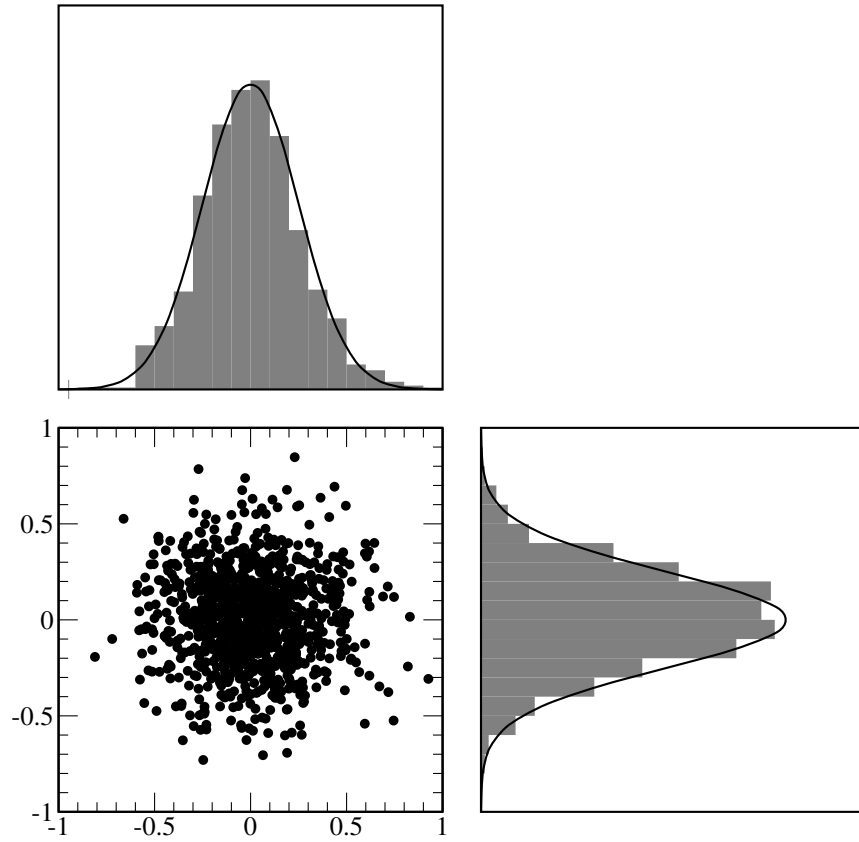


Figure 90: Testing random number generation [random.m4].

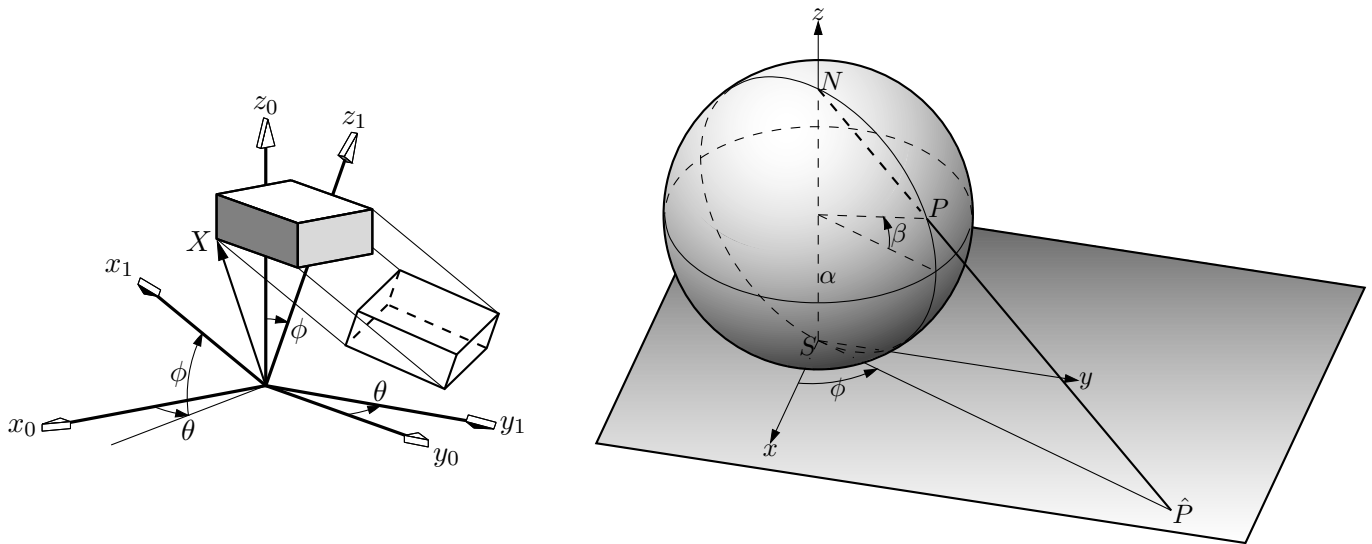


Figure 91: Test of project and other lib3D macros, showing the projection of a solid onto the  $y_1, z_1$  plane by sighting along the  $x_1$  axis. [exp.m4].

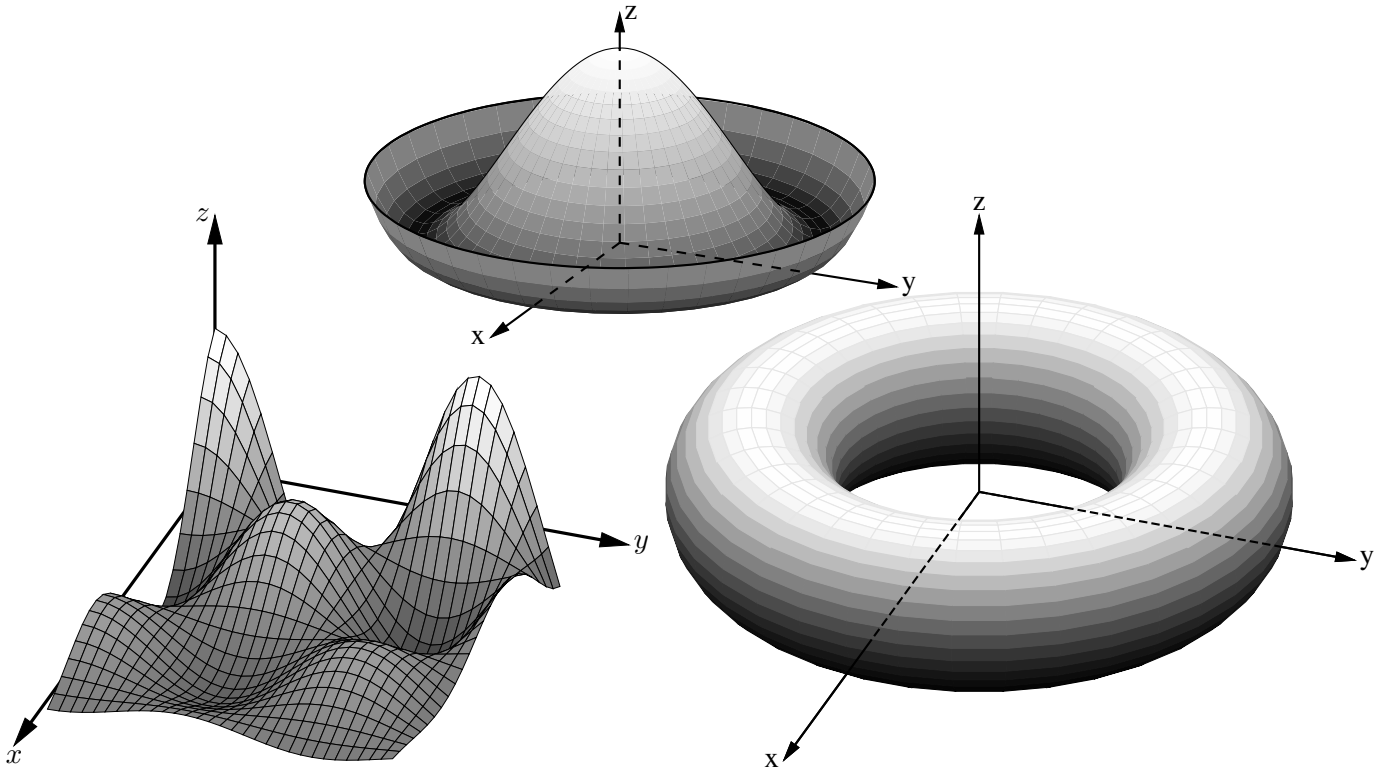


Figure 92: Plotting surfaces using gray scales. A sort algorithm determines plotting order [graysurf.m4].

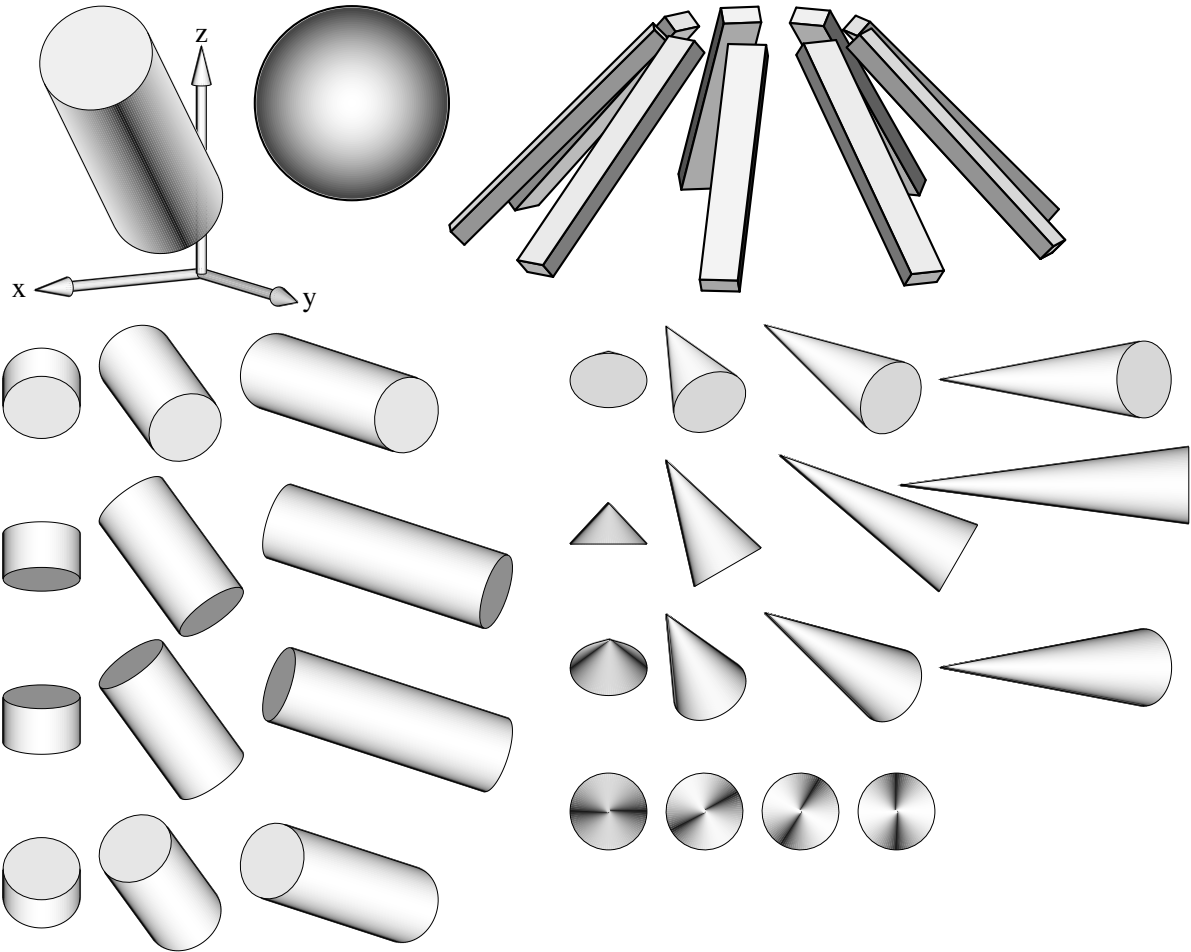


Figure 93: Basic shapes [shapes.m4].

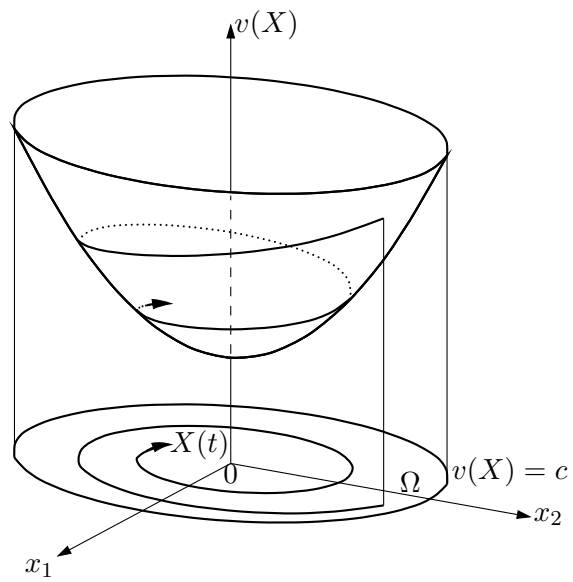


Figure 94: Illustrating a Lyapunov function [Lyap.m4].

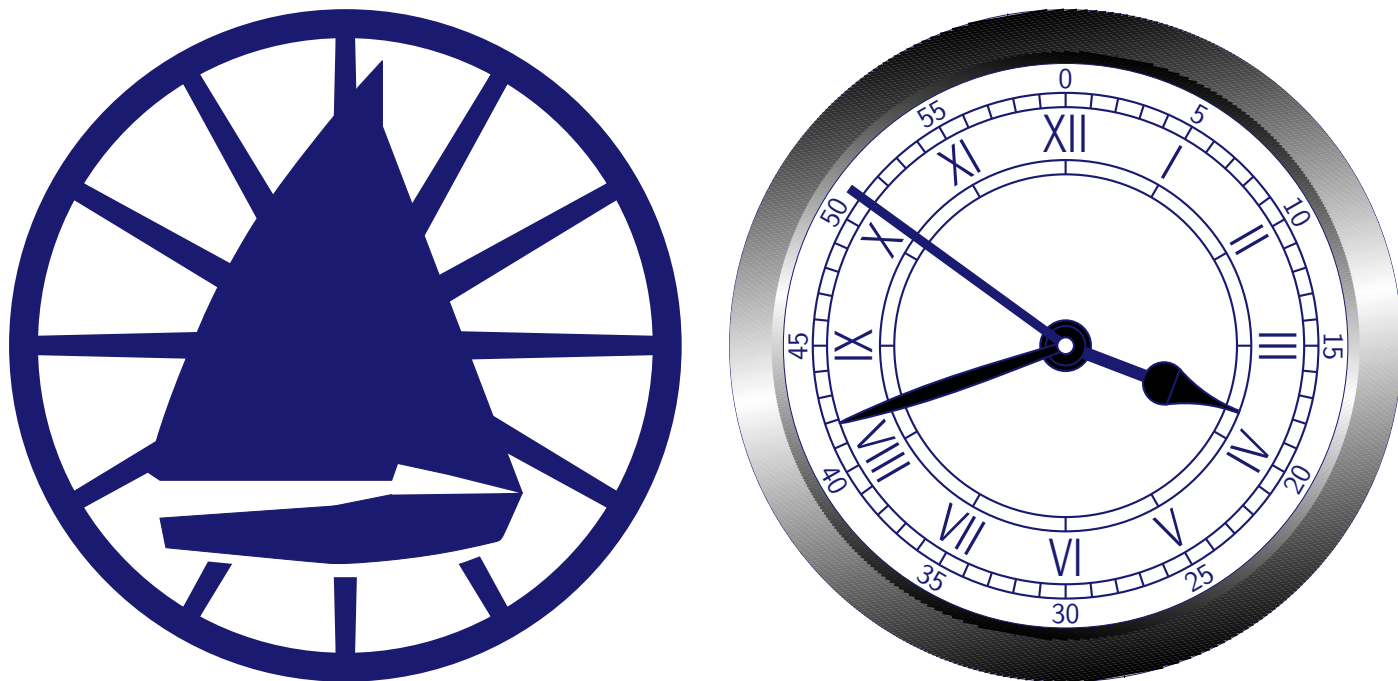


Figure 95: Conestoga Sailing Club (illustrating the filling of arbitrary shapes) and an antique clock face with shading and rotated text [csc.m4].

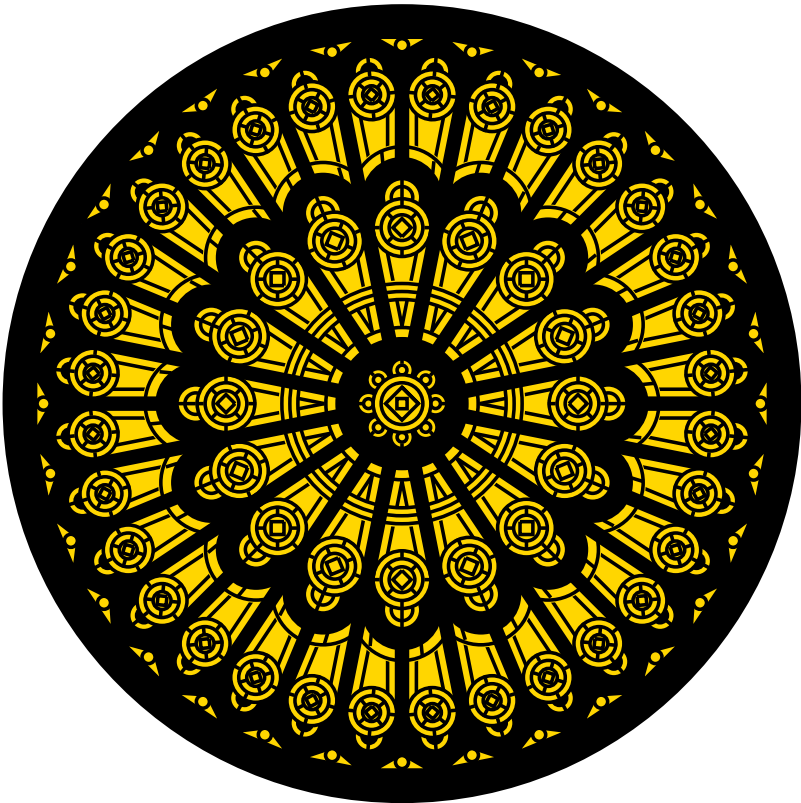


Figure 96: Redrawn from a detail of the set design for the musical *Dracula*, used for testing `dpic`. This diagram consumes much  $\LaTeX$  main memory but can be produced directly as pdf using `dpic -d`, as svg using `dpic -g`, or as postscript using `dpic -r` since no text formatting is required [rose.m4].

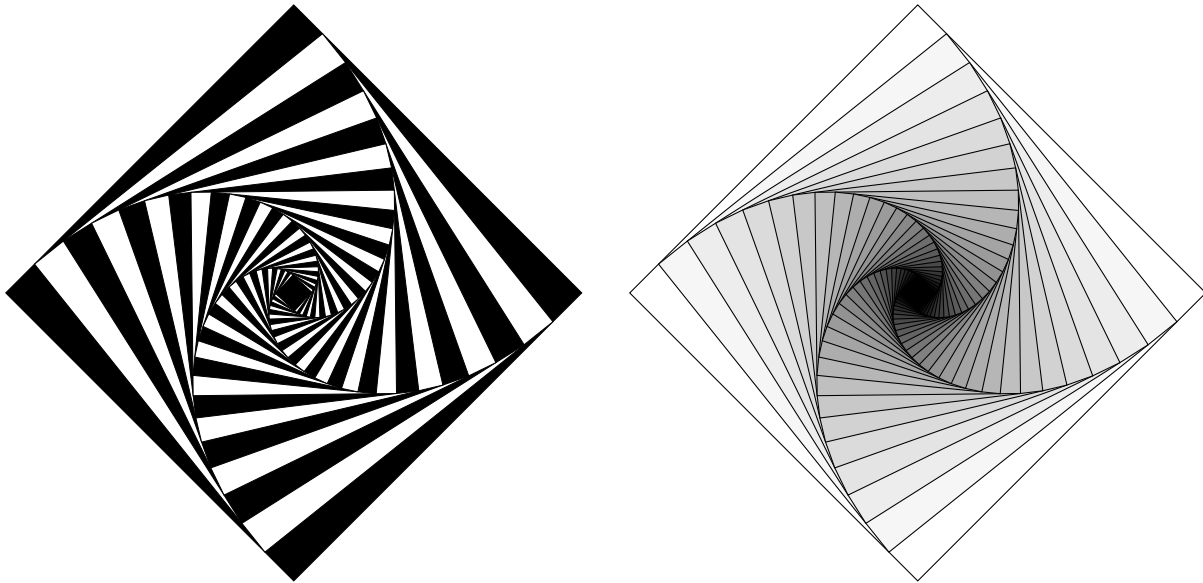


Figure 97: Variations on M. Goossens, S. Rahtz, and F. Mittelbach, *The L<sup>A</sup>T<sub>E</sub>X Graphics Companion*, Addison-Wesley 1997, pp. 57-58 [diamond.m4].

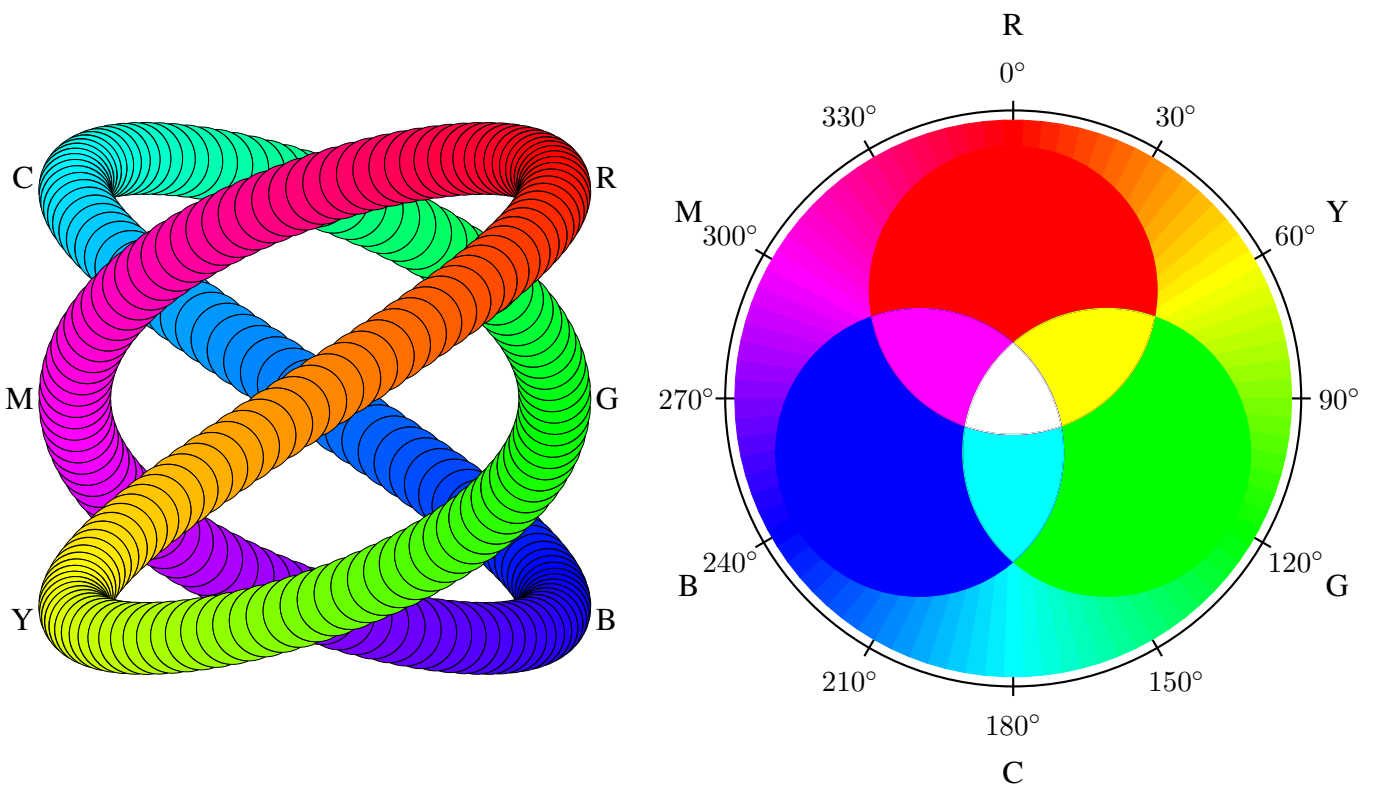


Figure 98: An exercise in calculating RGB colours [worm.m4].



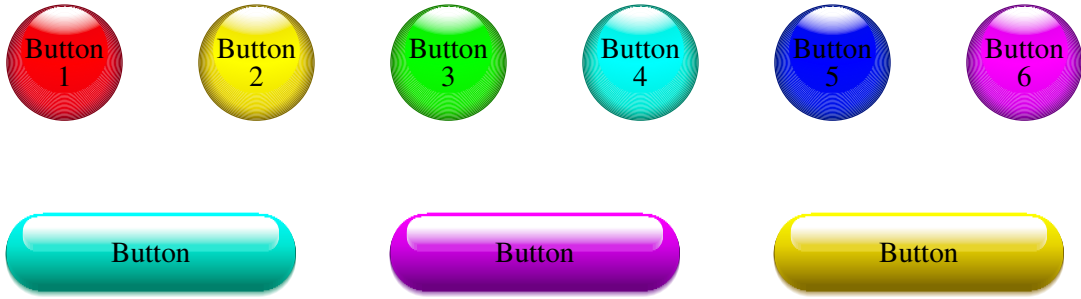


Figure 99: Shading in color [Buttons.m4].

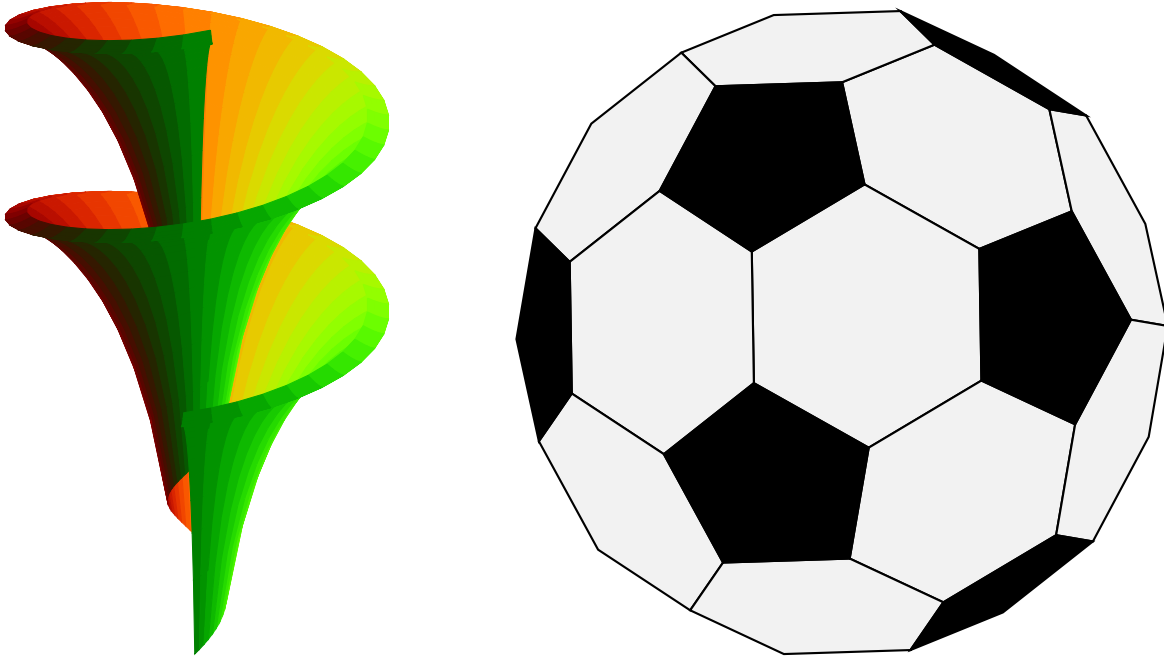


Figure 100: Dini surface and an icosahedron [Dini.m4].

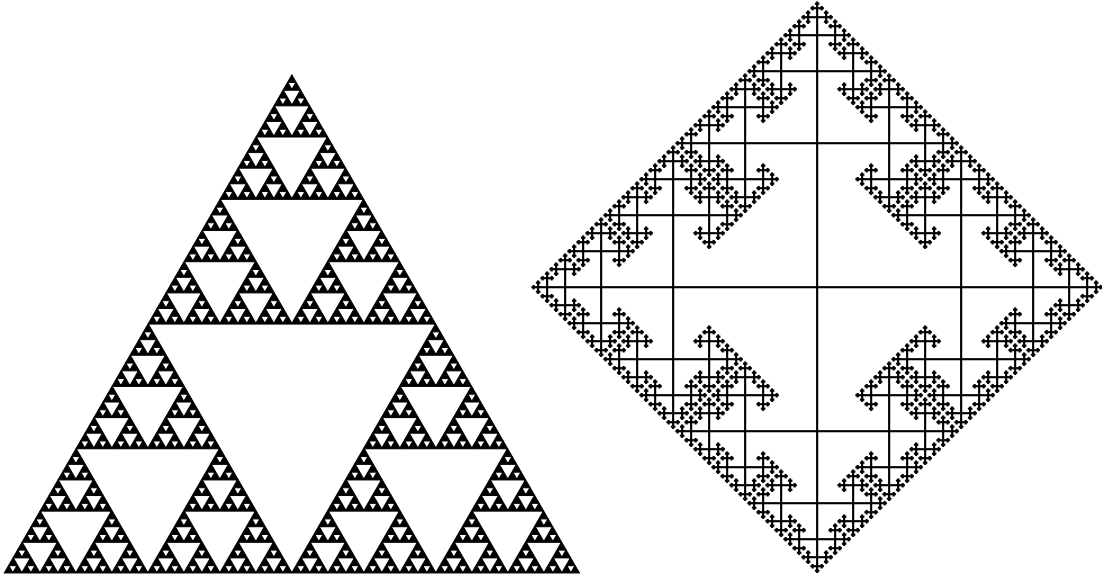


Figure 101: The Sierpinski triangle and a Cayley graph: tests of pic macro recursion [Sierpinski.m4].

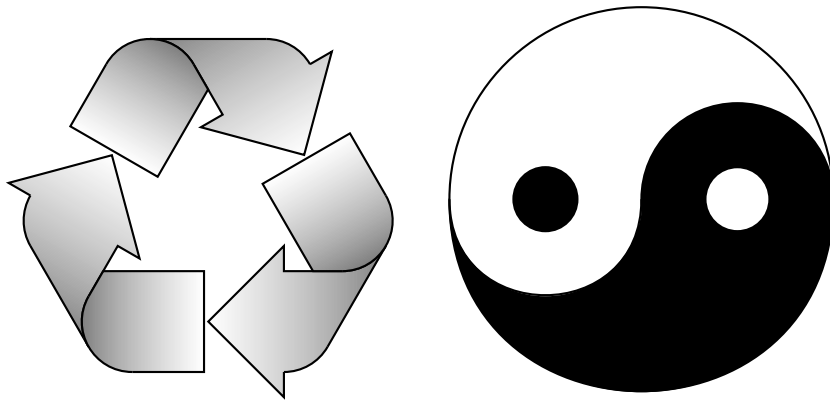


Figure 102: Modest repetition and partial fill [recycle.m4].

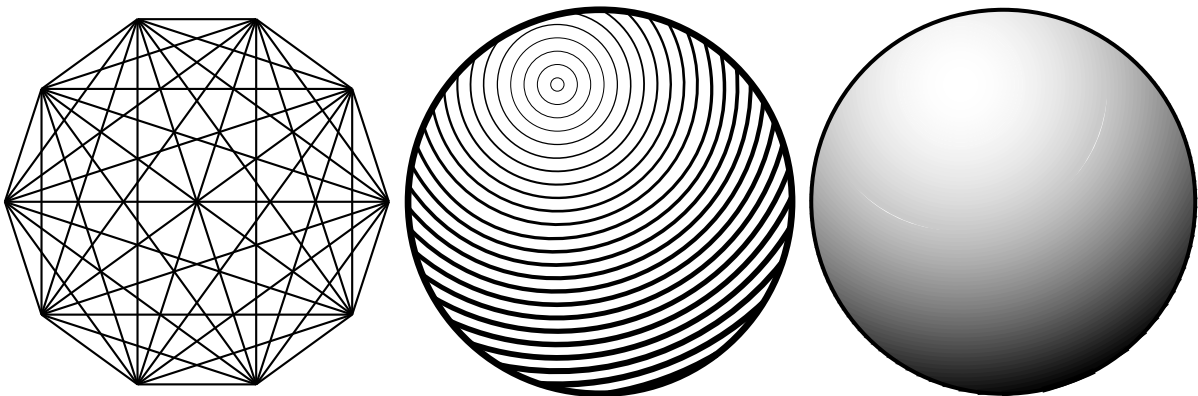


Figure 103: Simple diagrams that are easily drawn by looping [ex15.m4].

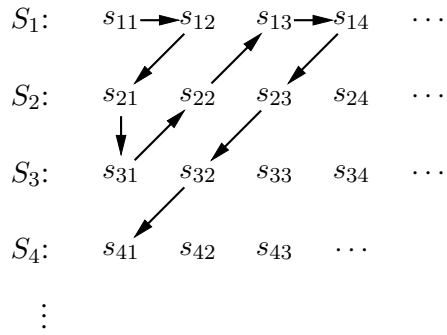


Figure 104: An example of enumeration srcCounting.m4.

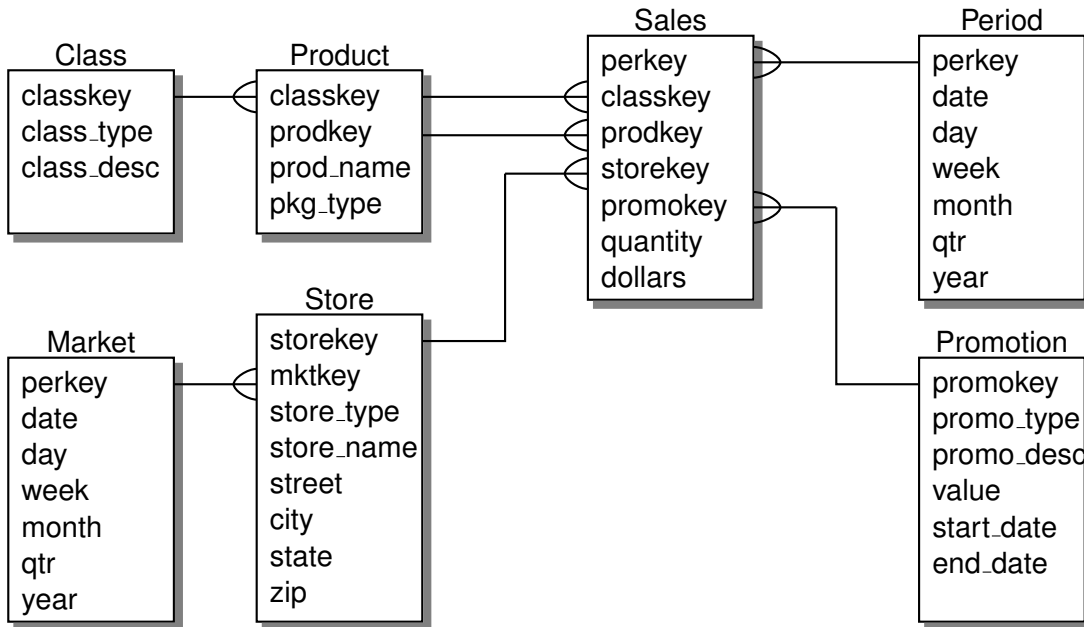


Figure 105: Illustrating shadebox and a custom crowfoot line termination [Crow.m4].

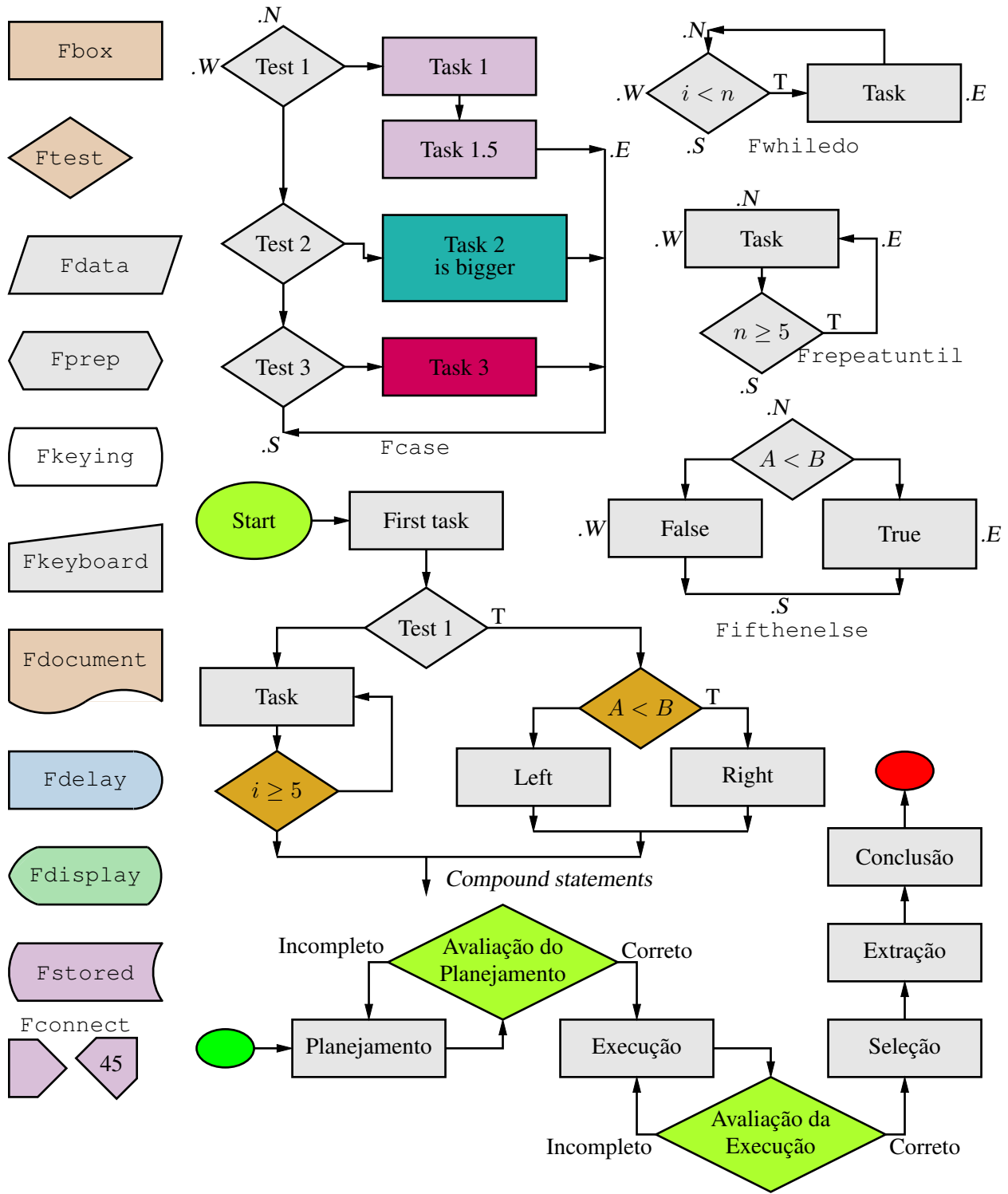


Figure 106: A flowchart sampler [Flow.m4].

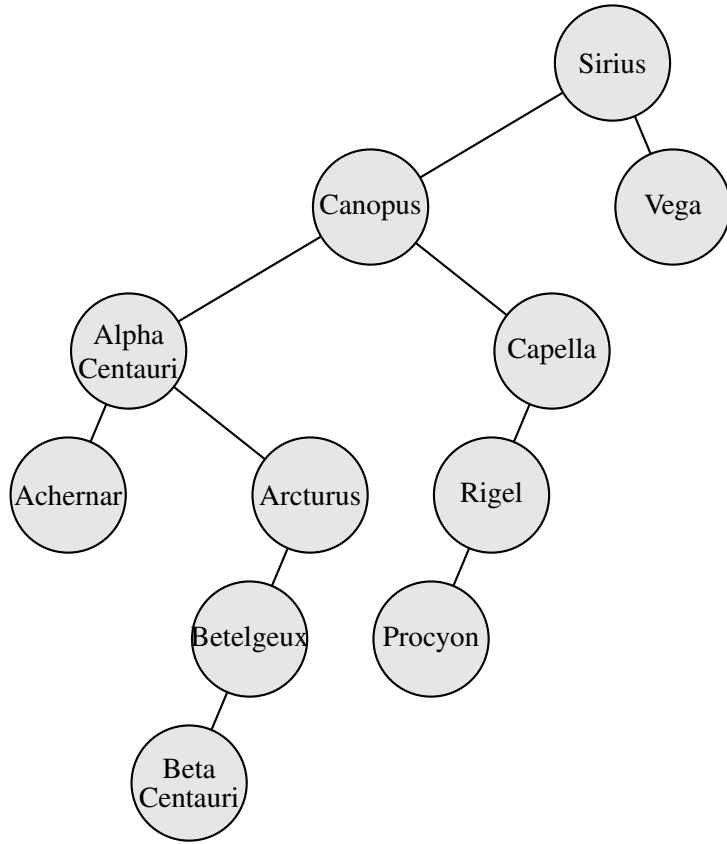


Figure 107: A binary tree [Btree.m4].

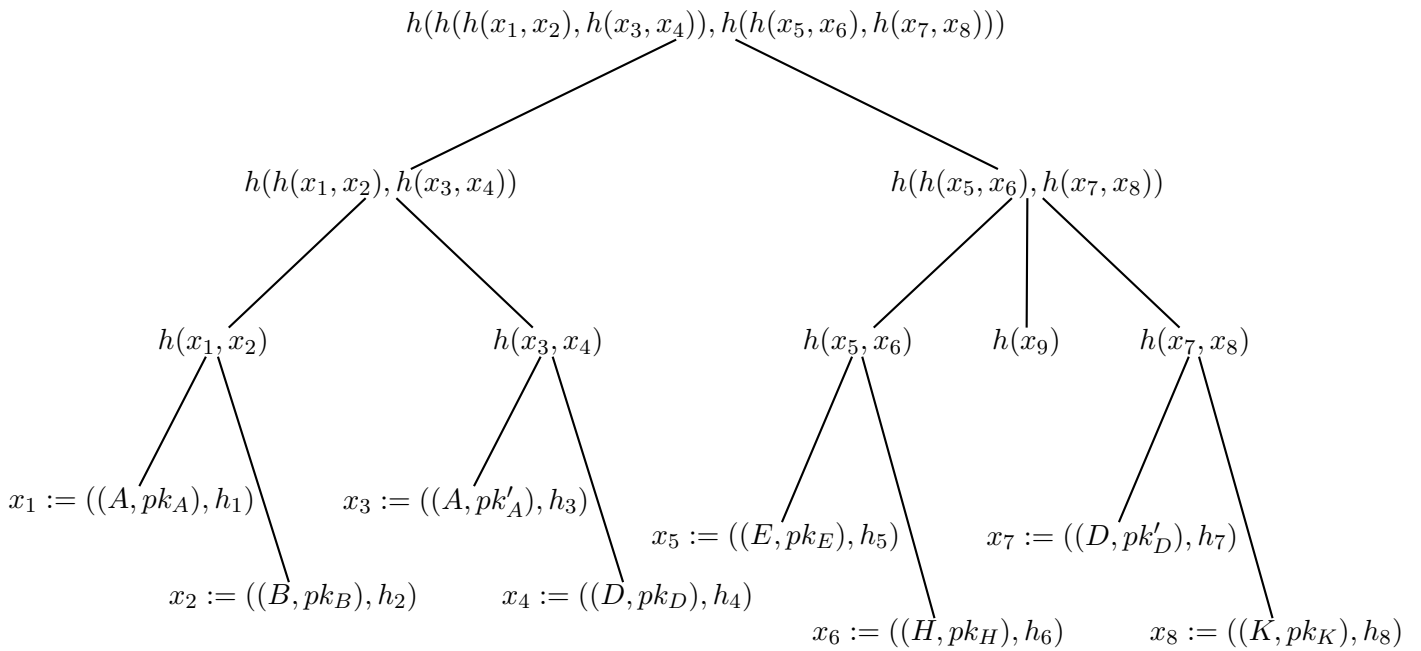


Figure 108: Another tree [Ttree.m4].



Figure 109: Overlaying a figure with line graphics [Incleps.m4].