

Examples: Version 10.9

This is a collection of diagrams the author has had occasion to produce using m4 circuit macros and others, and dpic or gpic.

Some lists of elements from the manual Circuit_macros.pdf are included. Producing diagrams starting from a list of elements is like writing poetry starting from a list of words, so a variety of small and medium circuits and other diagrams is also included here in the expectation that you might wish to adapt some of them to your purposes. There may be 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 are achieved by sticking to one pic interpreter and one postprocessor.

Color and other embellishments are not included in the standards documents for circuit elements but examples of their use to call attention to particular elements are included.

The source files can be processed individually. To produce .pdf from *file.m4*, for example, type “make *file.pdf*”. Type “make” in the extras directory to see more.

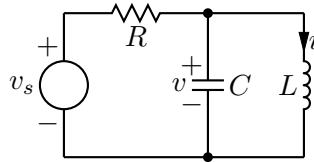


Figure 1: The quick-start example from the manual [quick.m4].

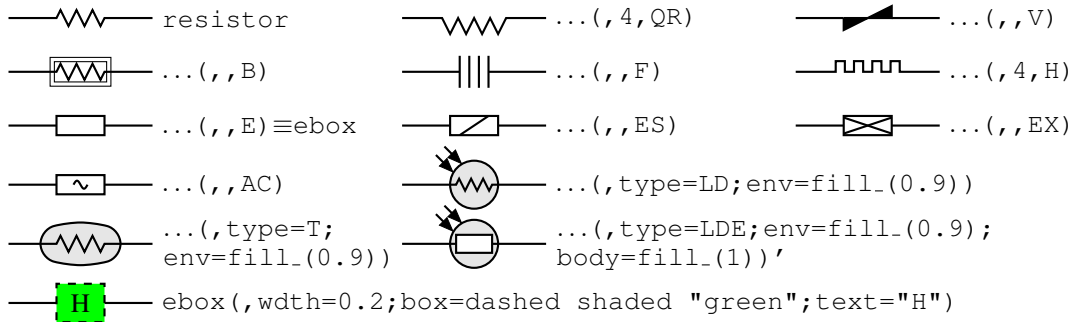


Figure 2: Resistors, showing some variations and the ebox [Resistors.m4].

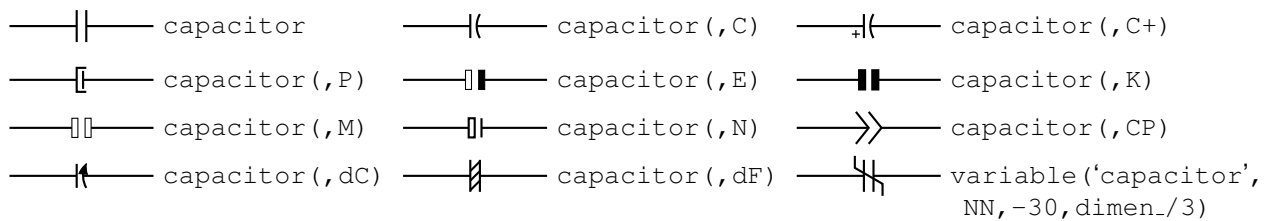


Figure 3: Capacitors [Capacitors.m4].

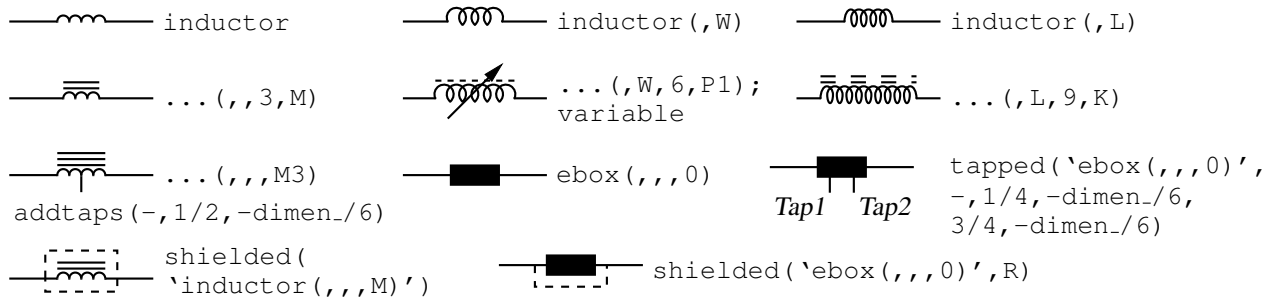


Figure 4: Inductors [Inductors.m4].

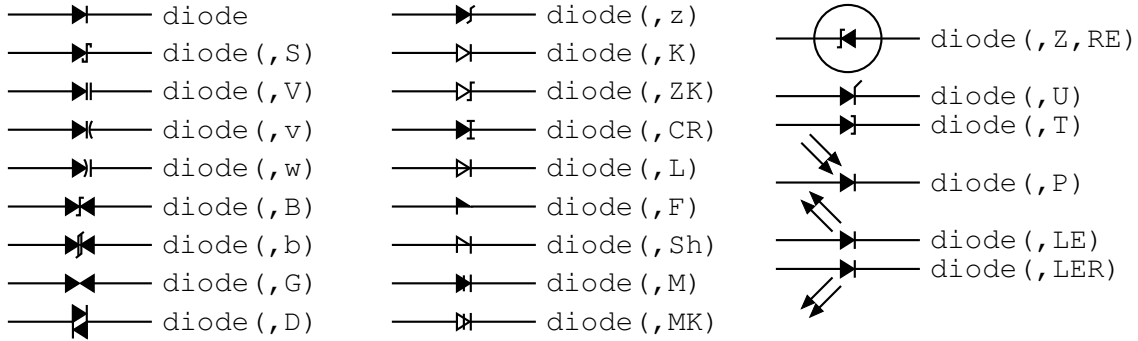


Figure 5: Diodes: appending a K to the second argument draws an open arrowhead [Diodes.m4].

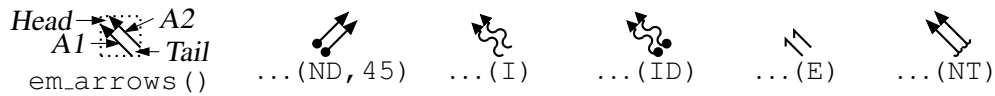


Figure 6: Radiation arrows [Emarrows.m4].

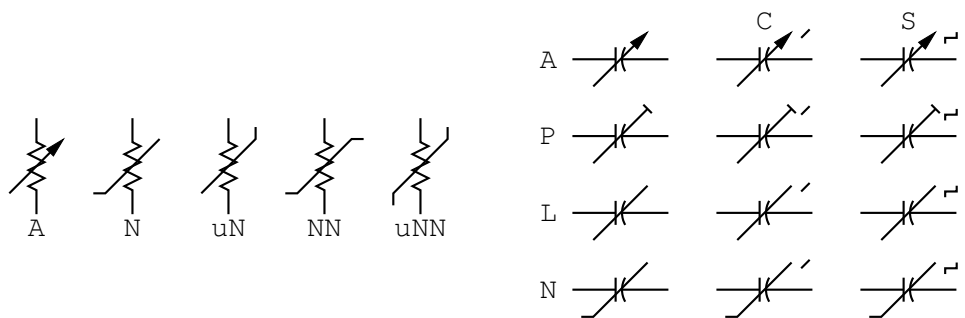


Figure 7: Arrows and marks for showing variability [Variable.m4].

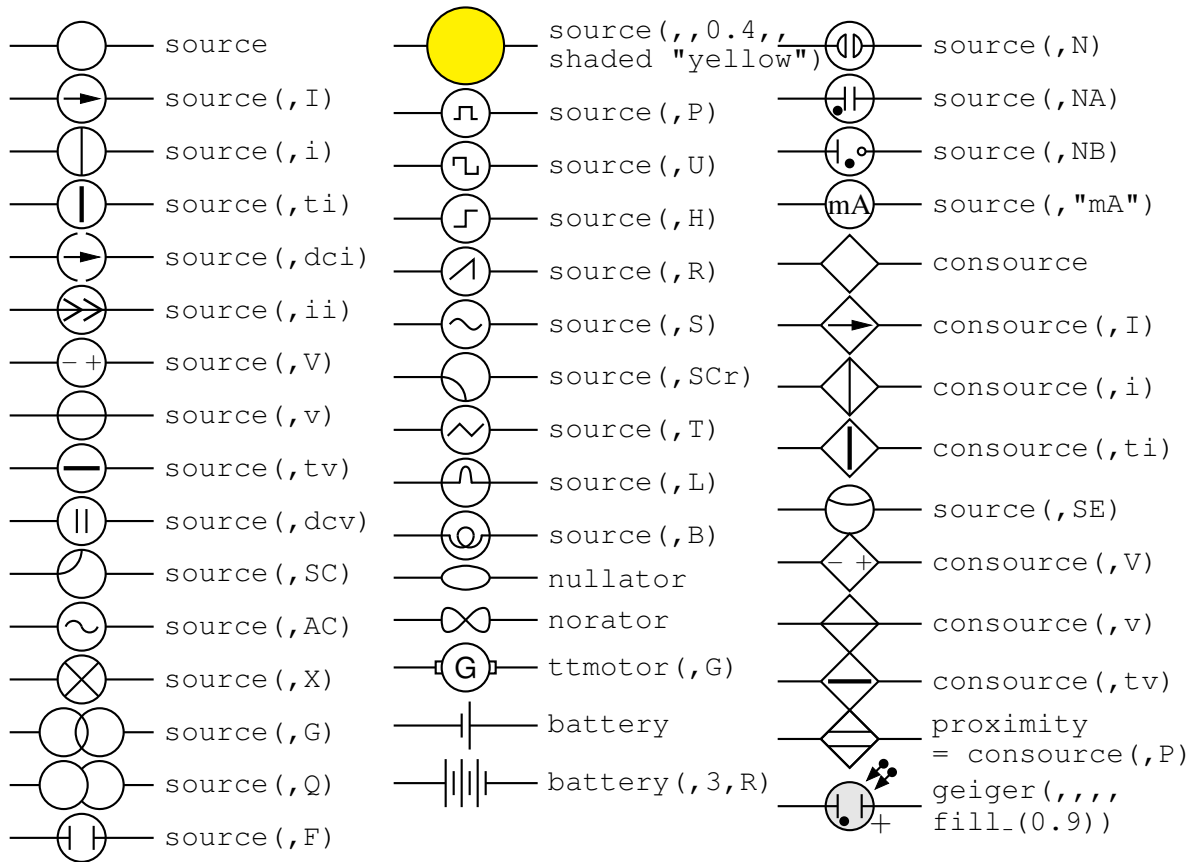


Figure 8: Sources and source-like elements [Sources.m4].

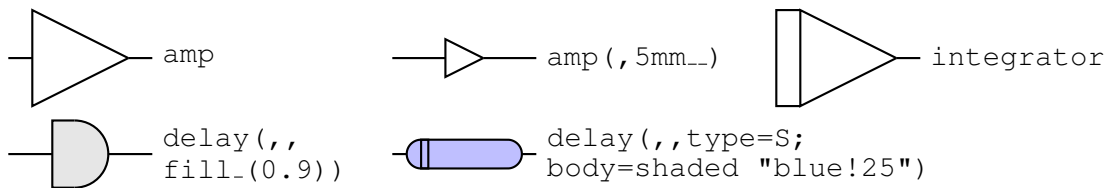


Figure 9: Macros amp, delay, and integrator [AmpTable.m4].

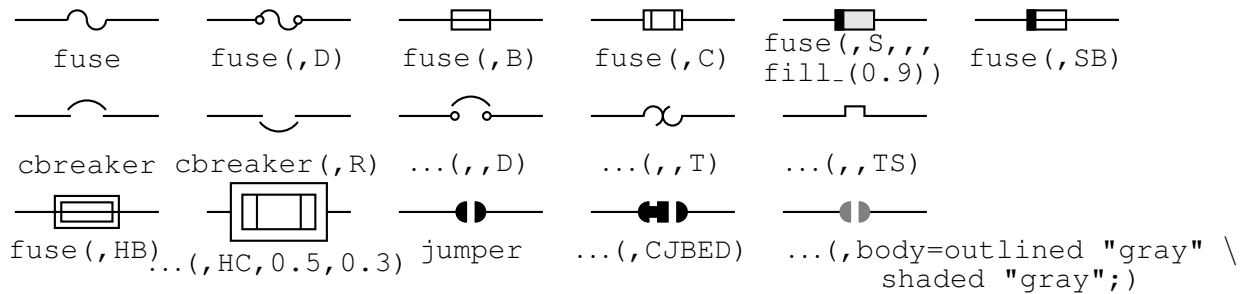


Figure 10: Macros fuse, cbreaker, and jumper [Fuses.m4].

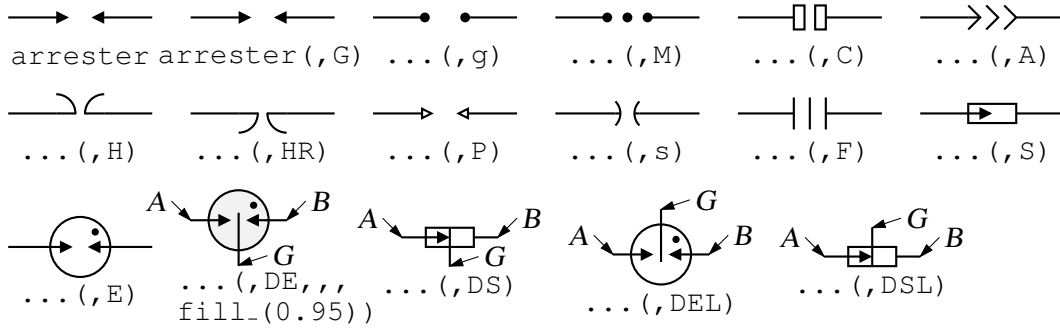


Figure 11: The arrester macro [Arresters.m4].

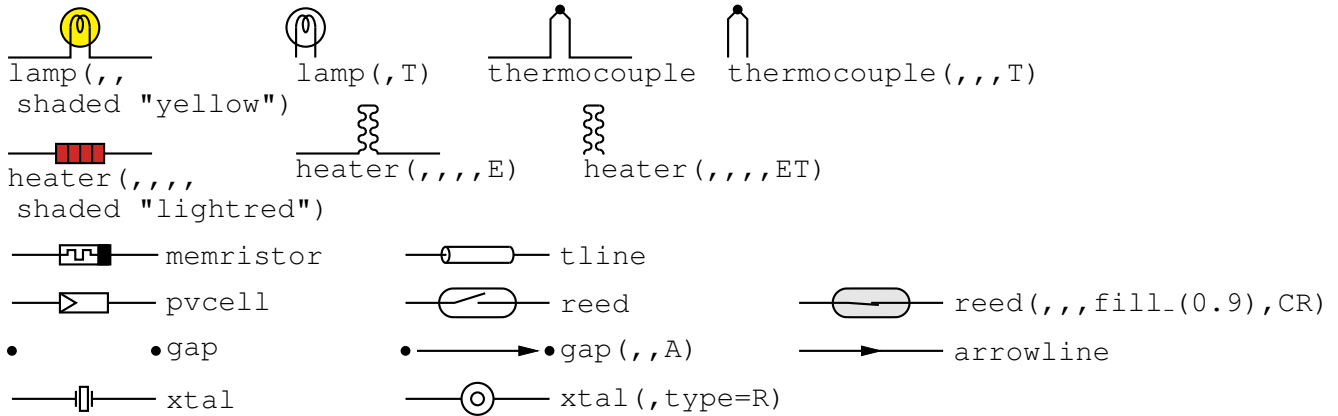


Figure 12: Additional two-terminal elements [MoreTable.m4].

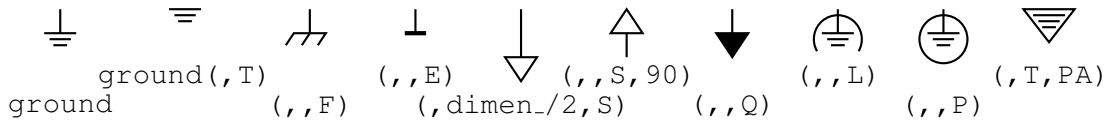


Figure 13: Ground symbols [Grounds.m4].

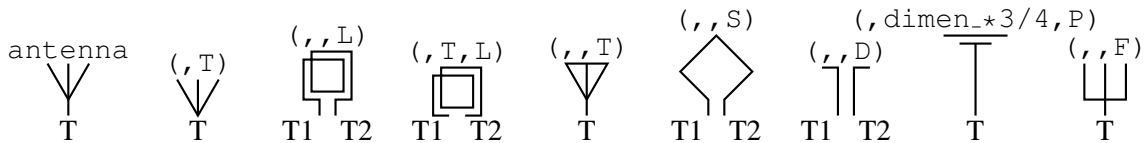


Figure 14: Antenna symbols [Antennas.m4].

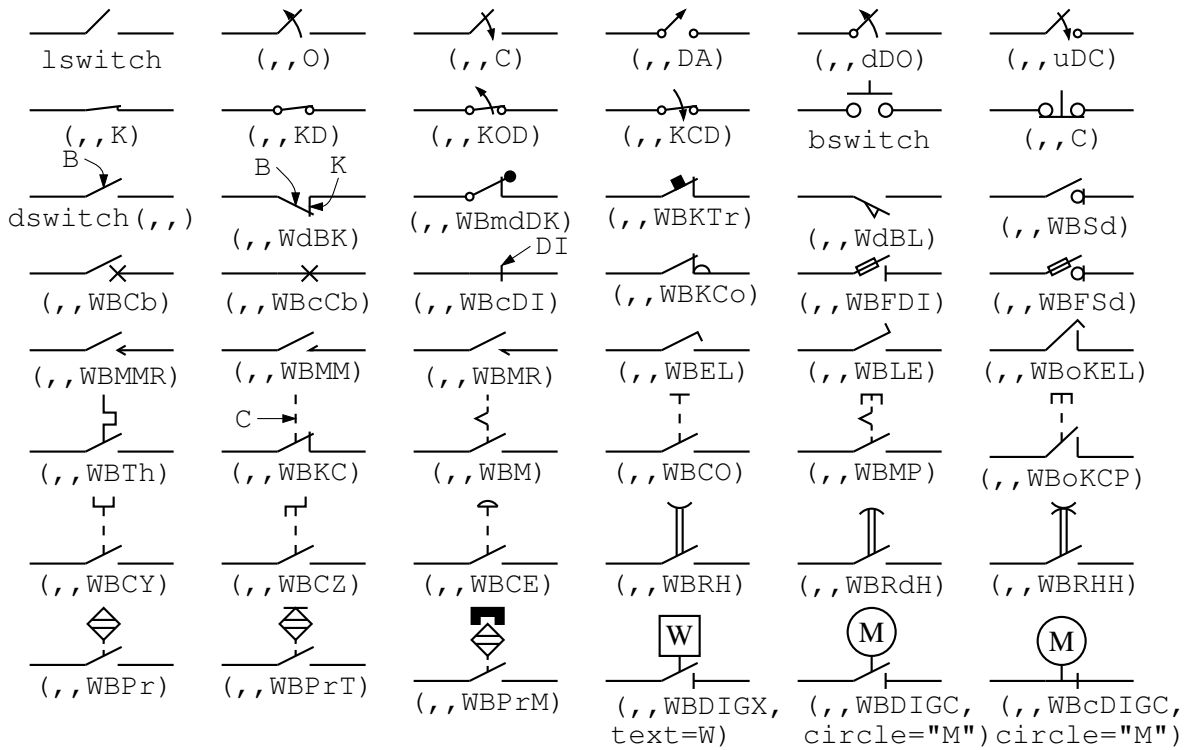


Figure 15: The switch macros; switch(, , L|D) is a wrapper for lswitch, bswitch, and dswitch [Switches.m4].

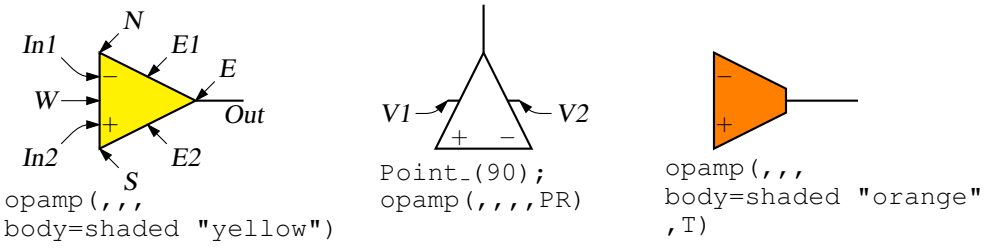


Figure 16: The opamp [Opamp.m4].

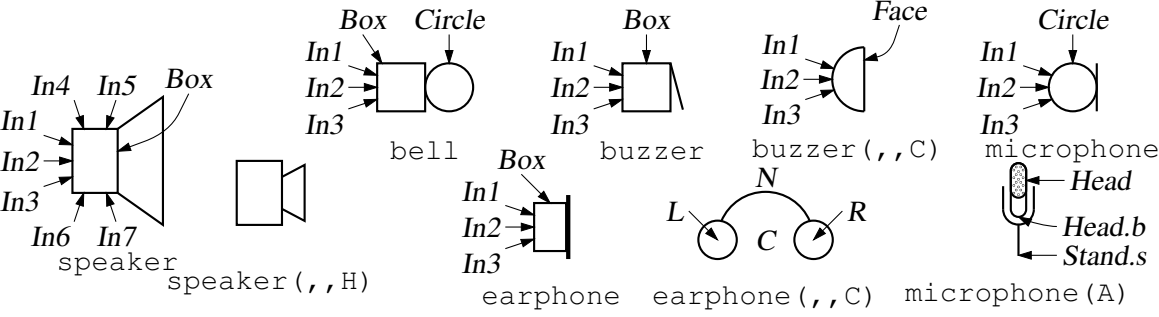


Figure 17: Audio elements [Audio.m4].

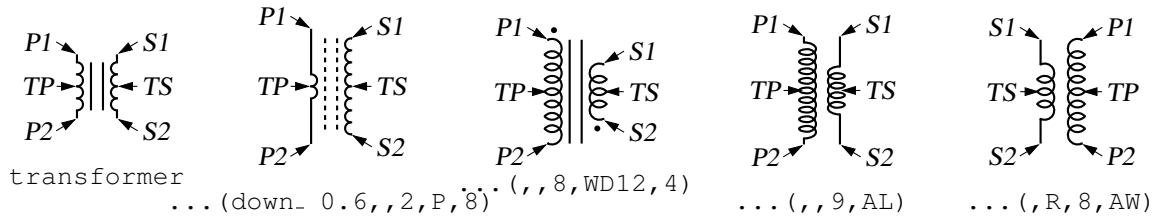


Figure 18: Some variations of the transformer element, drawing direction down [Xform.m4].

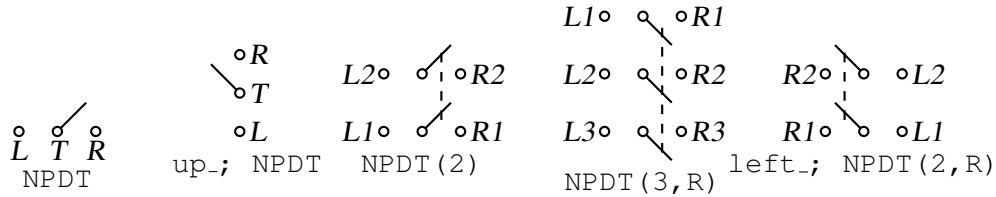


Figure 19: Double throw with the NPDT macro [NPDT.m4].

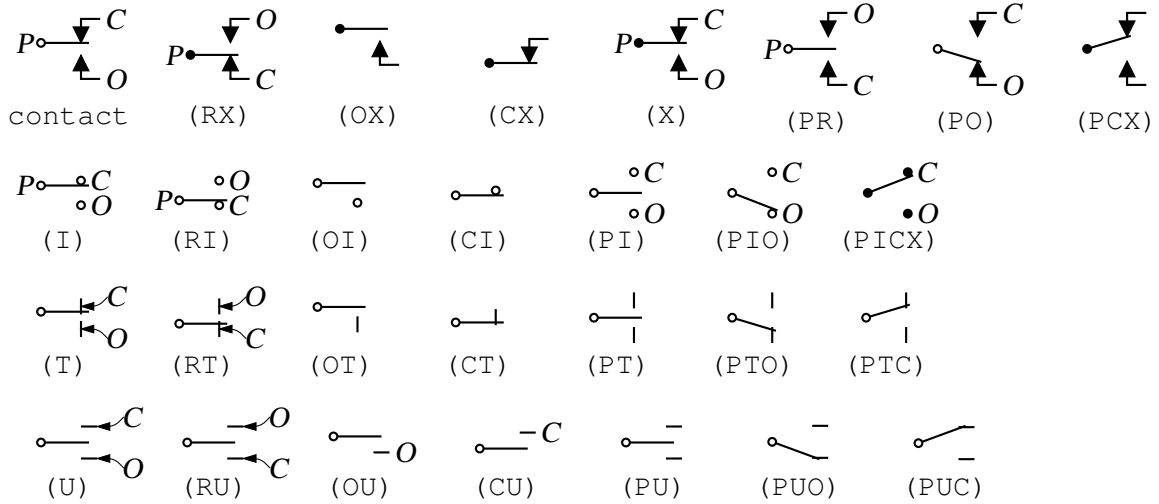


Figure 20: A non-exhaustive sampling of contact macro variations [Contact.m4].

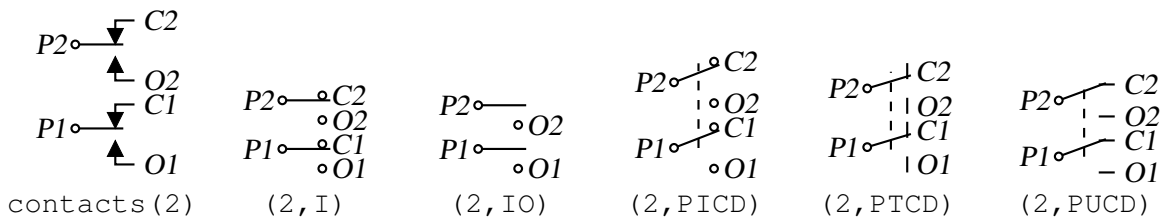


Figure 21: The contacts macro [Contacts.m4].

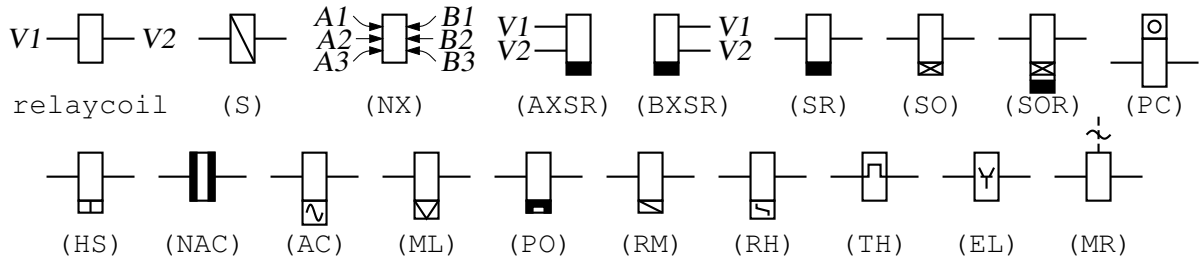


Figure 22: The relaycoil macro [relaycoil.m4].

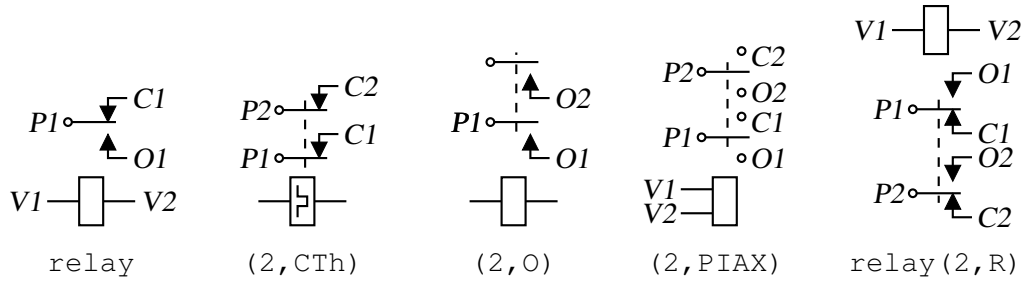


Figure 23: Some variants of relay [Relay.m4].

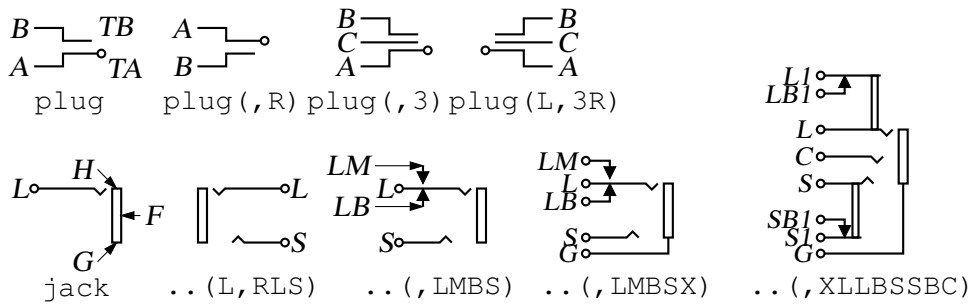


Figure 24: The jack and plug macros [Jack.m4].

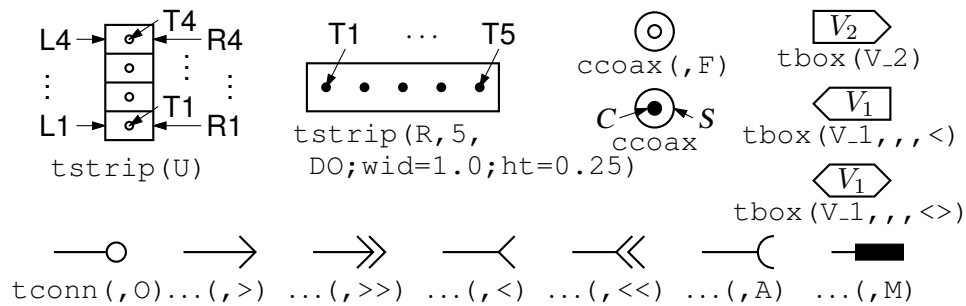


Figure 25: The tstrip, ccoax, tconn, and tbox macros [Conn.m4].

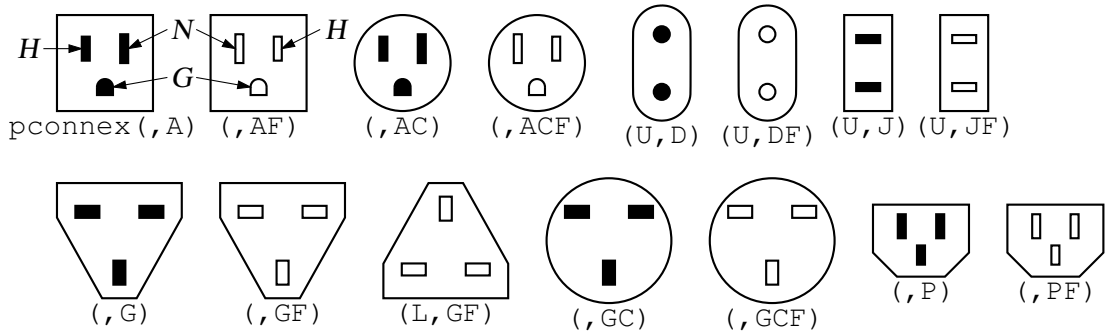


Figure 26: The pconnex macro [Pconn.m4].

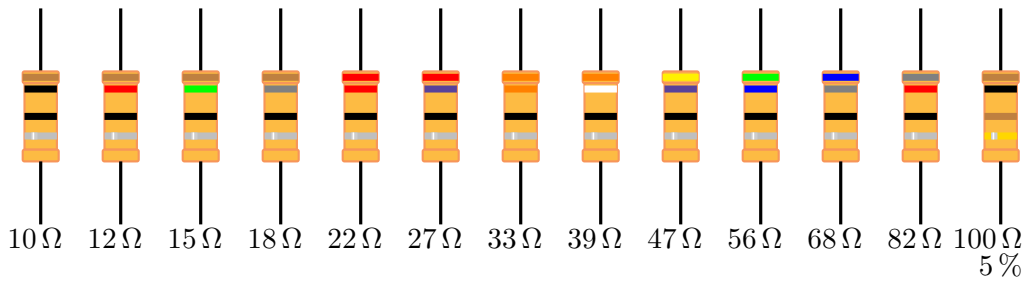


Figure 27: Color-coded through-hole resistors. All are 10 percent tolerance except the last, which illustrates 5 percent [cbresistor.m4].

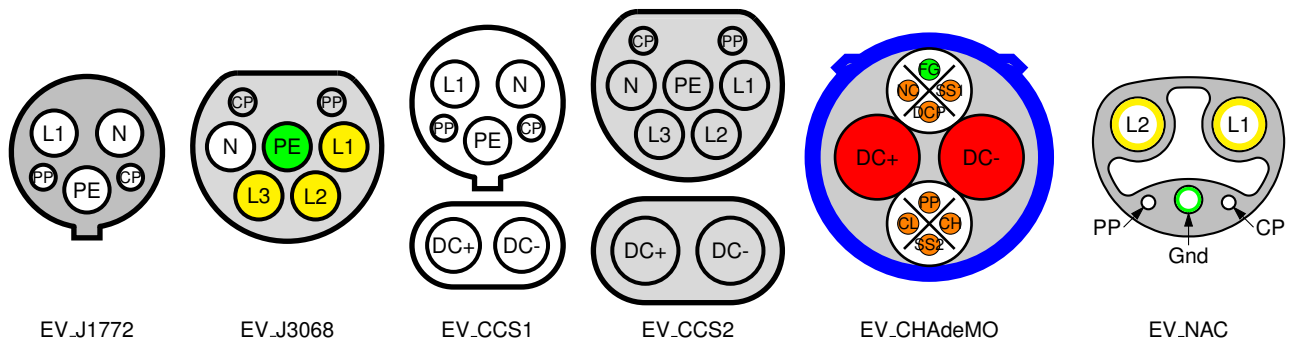


Figure 28: Electric vehicle charging plug patterns make extensive use of key=value pairs to set options [EVplugs.m4].

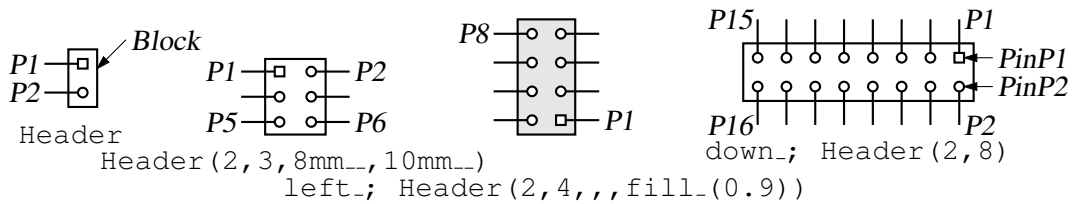


Figure 29: The Header macro [Headers.m4].

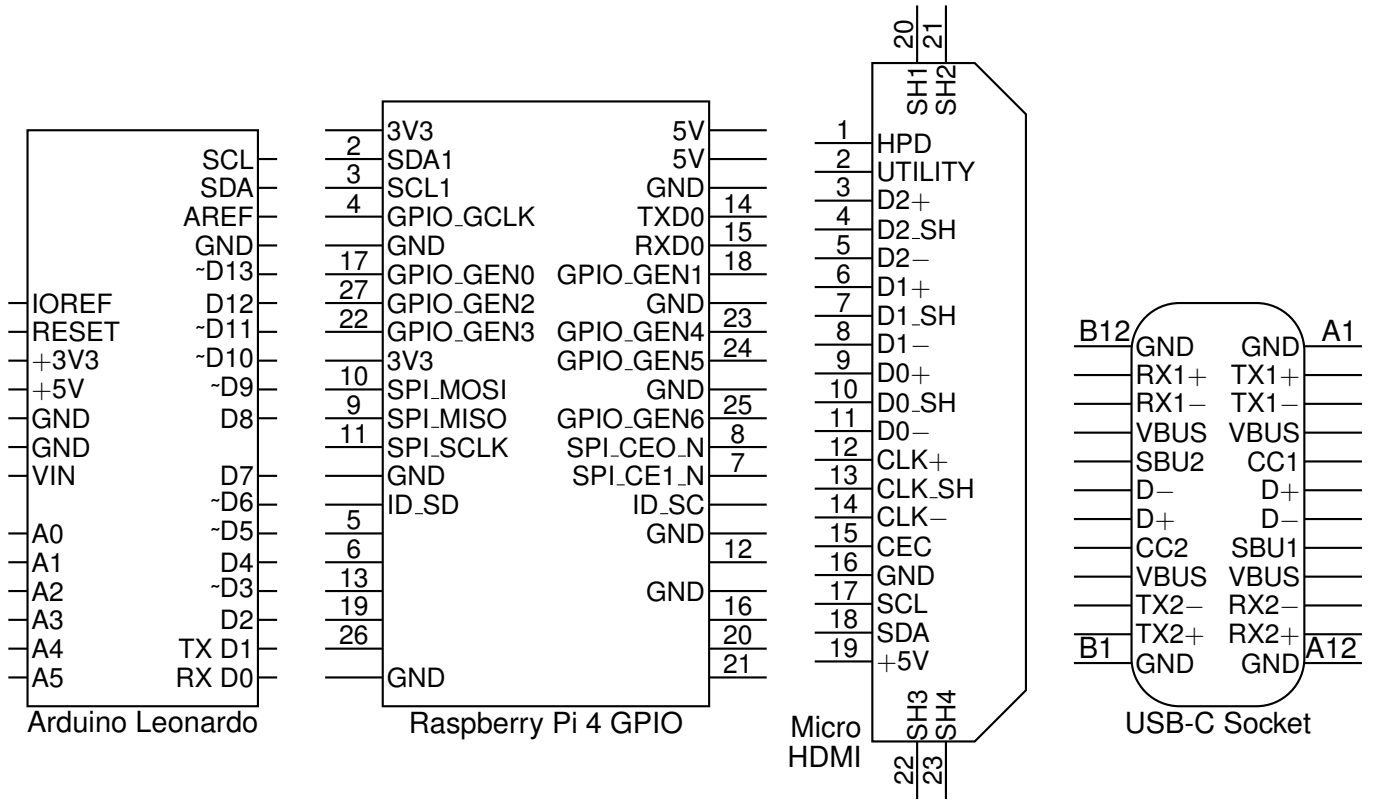


Figure 30: Some connectors with simple geometry and lists of labels [Connectors.m4].

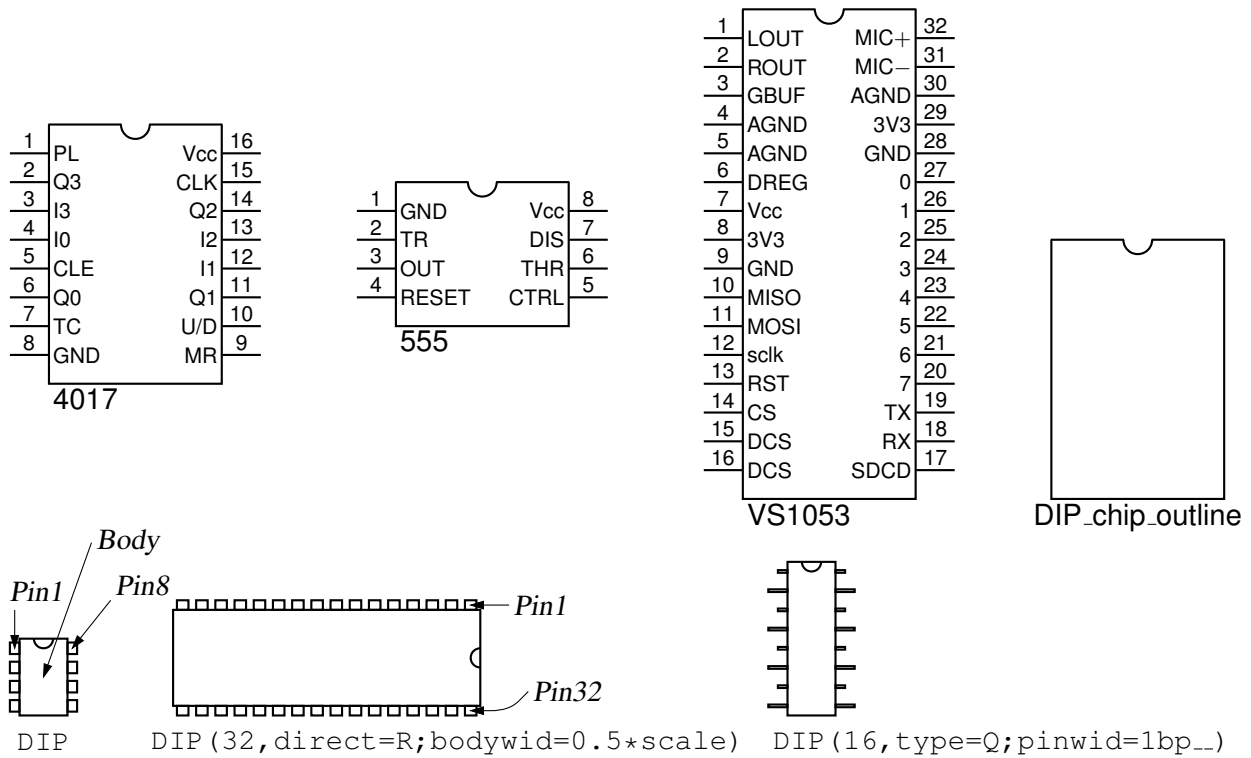


Figure 31: IC package outlines and examples [Chips.m4].

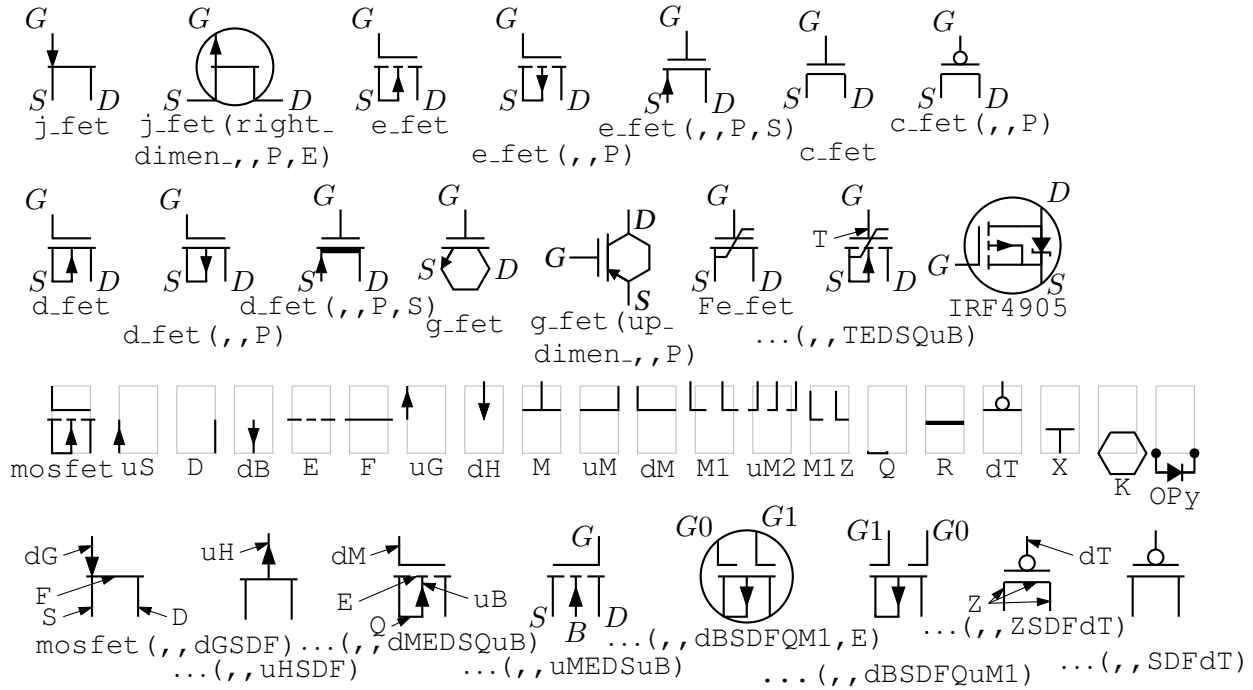


Figure 32: FETs, showing programmable components and example customizations [fet.m4].

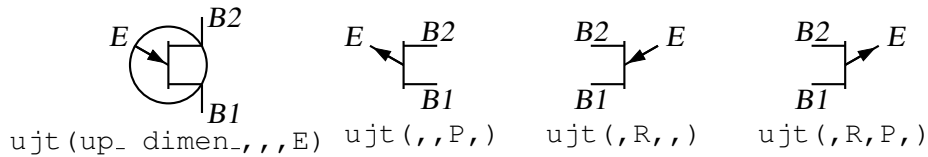


Figure 33: UJT examples [ujt.m4].

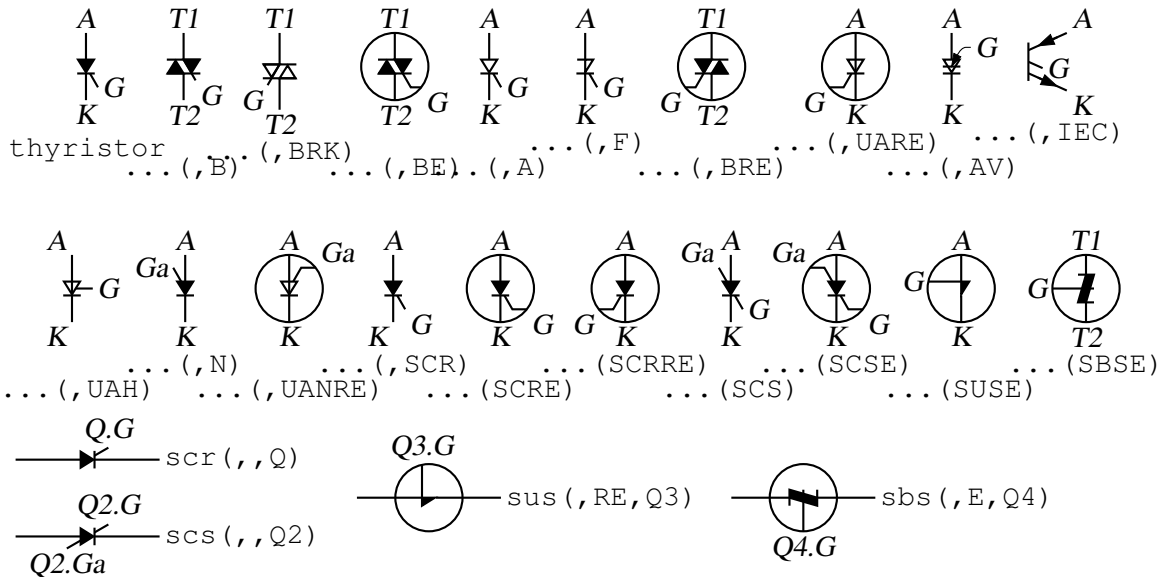


Figure 34: Thyristor examples. The thyristor is a 3- or 4-terminal composite element [thyristor.m4].

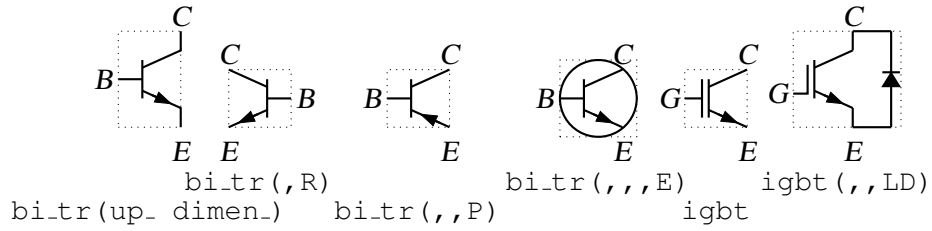


Figure 35: Bipolar transistors (drawing direction: up) [Bip.m4].

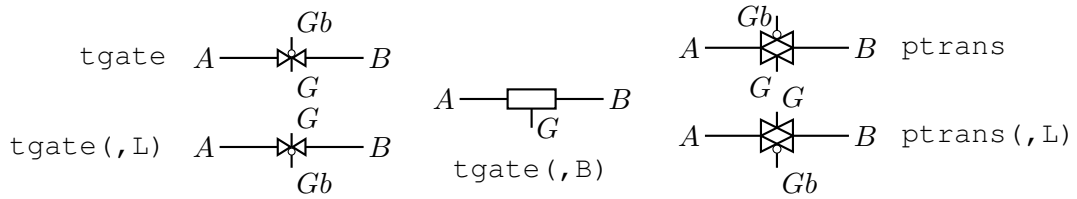


Figure 36: The tgate and ptrans elements [Tgate.m4].

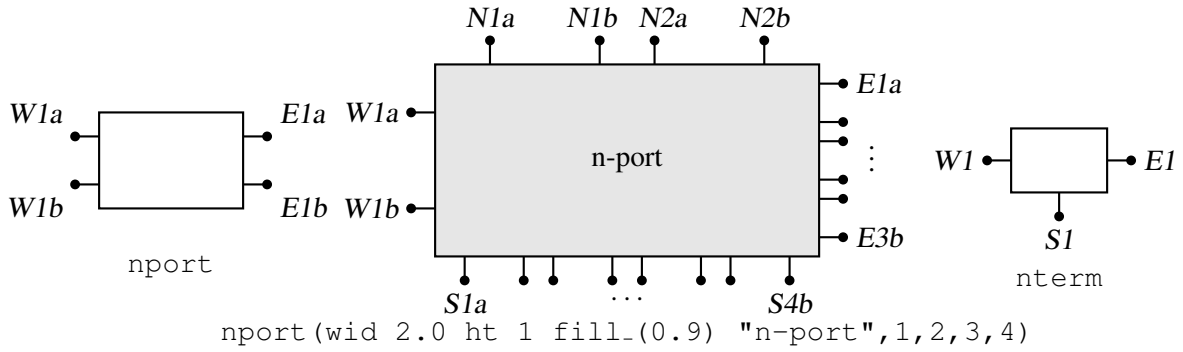


Figure 37: The nport and nterm macros [Nport.m4].

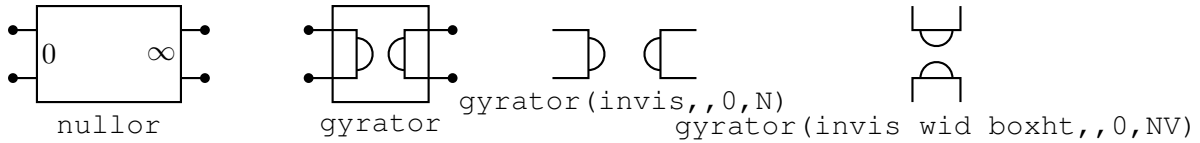


Figure 38: Some customizations of nport [NLG.m4].

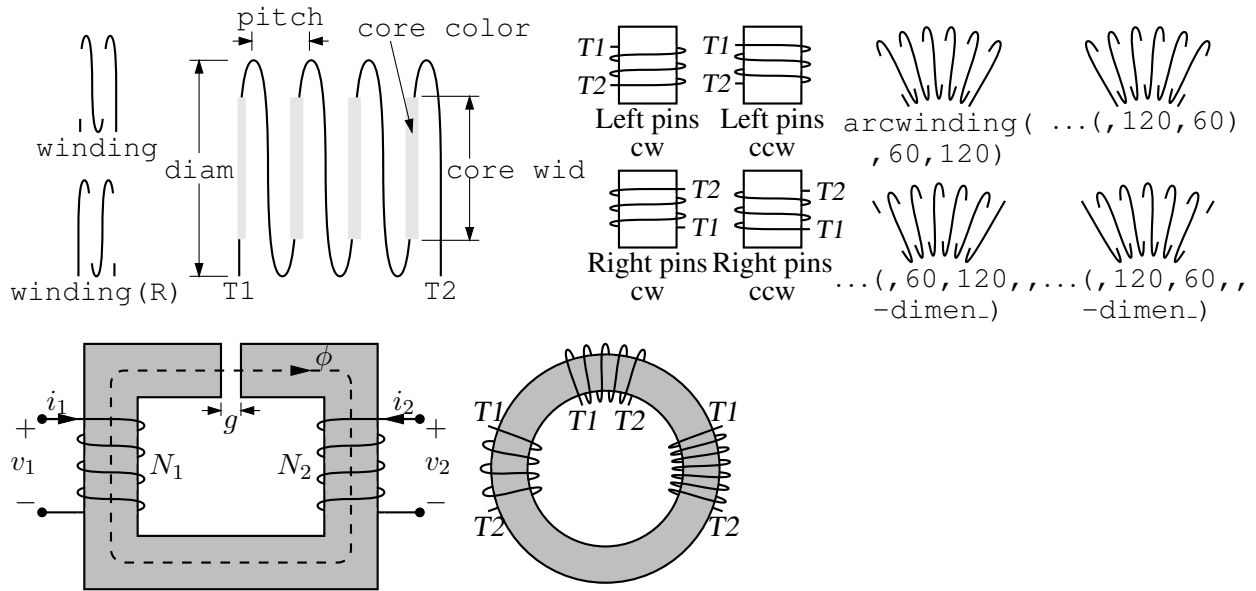


Figure 39: The macros winding(L|R,winding diam,pitch,nturns,core wid, "core color") and arcwinding(winding diam, start deg, enddeg, nturns, core centre rad, core wid, "core color") [Windings.m4].

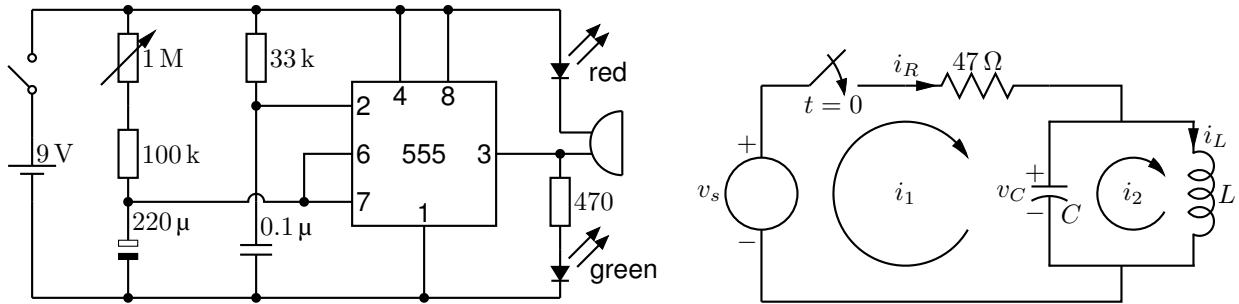


Figure 40: Two simple labeled circuits [ex01.m4].

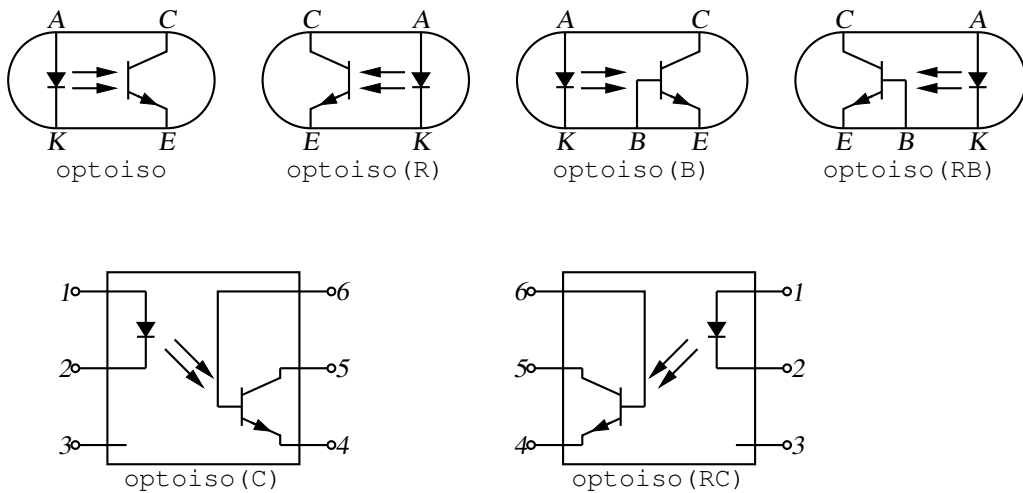


Figure 41: Optical isolator: a circuit with right or left orientation [Optoiso.m4].

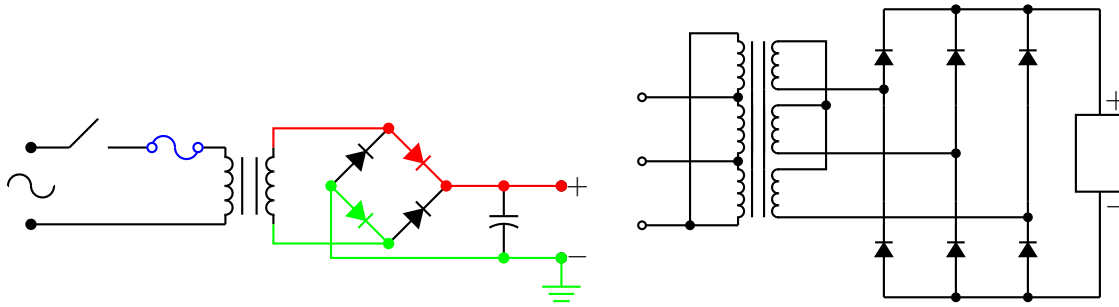


Figure 42: An elementary power supply circuit with colored elements, and a multiple-winding transformer with 3-phase rectifier [pwrsupply.m4].

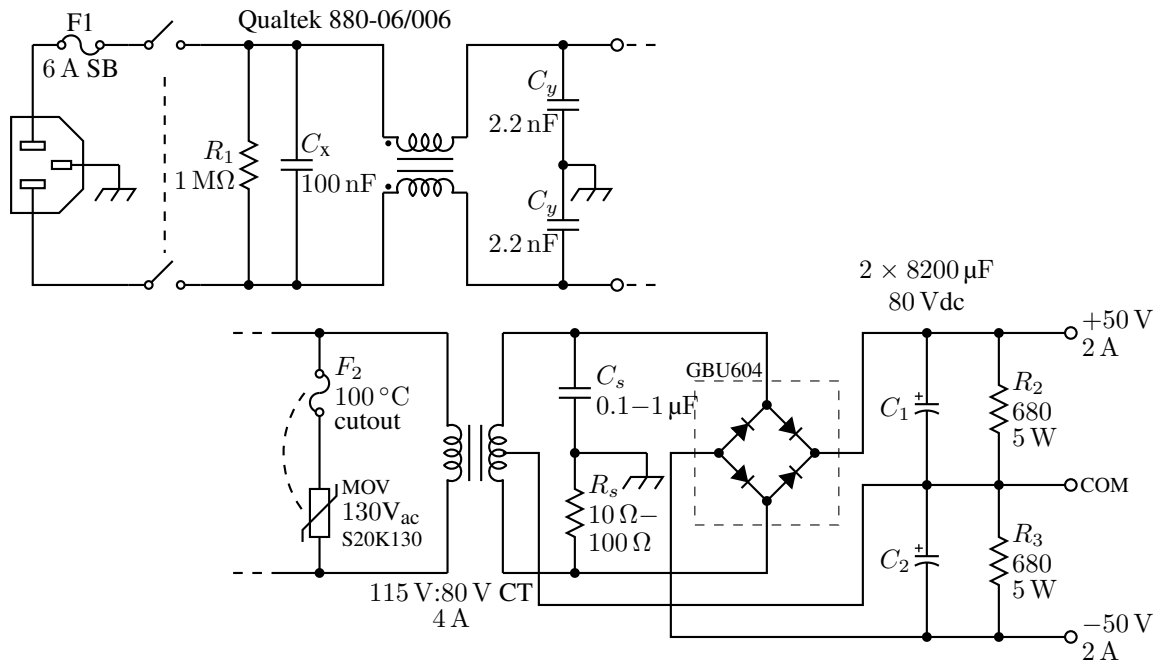


Figure 43: An unregulated 50V power supply [PS50.m4].

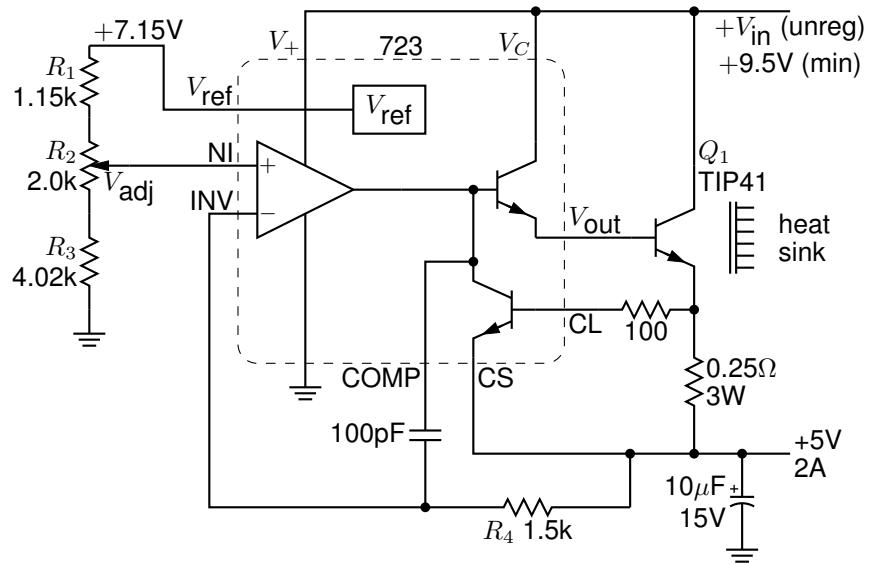


Figure 44: A 723 regulator circuit with a heat sink [Reg723.m4].

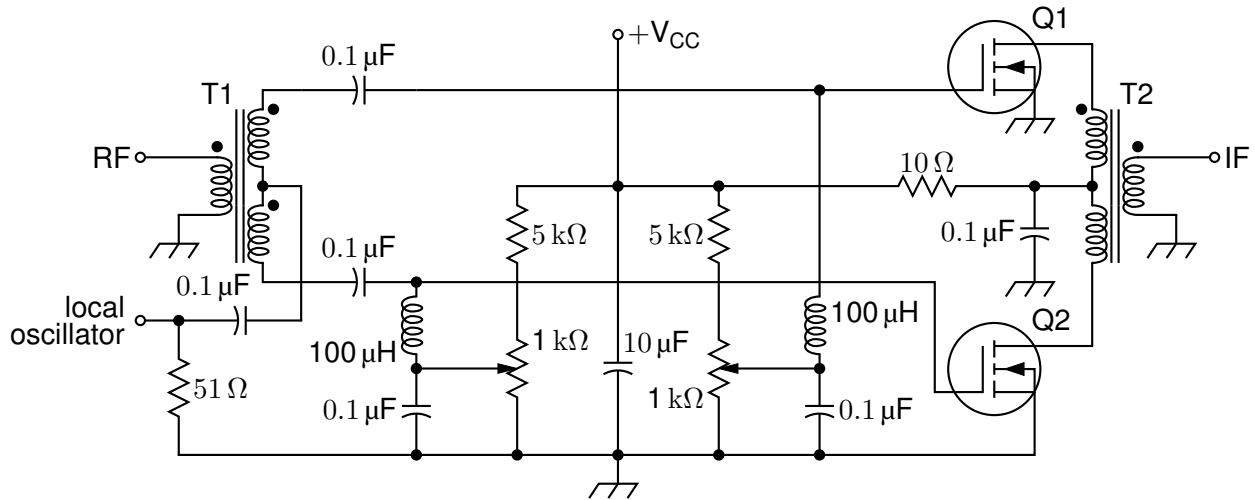


Figure 45: A balanced mixer, using mosfet and a custom transformer [Mixer.m4].

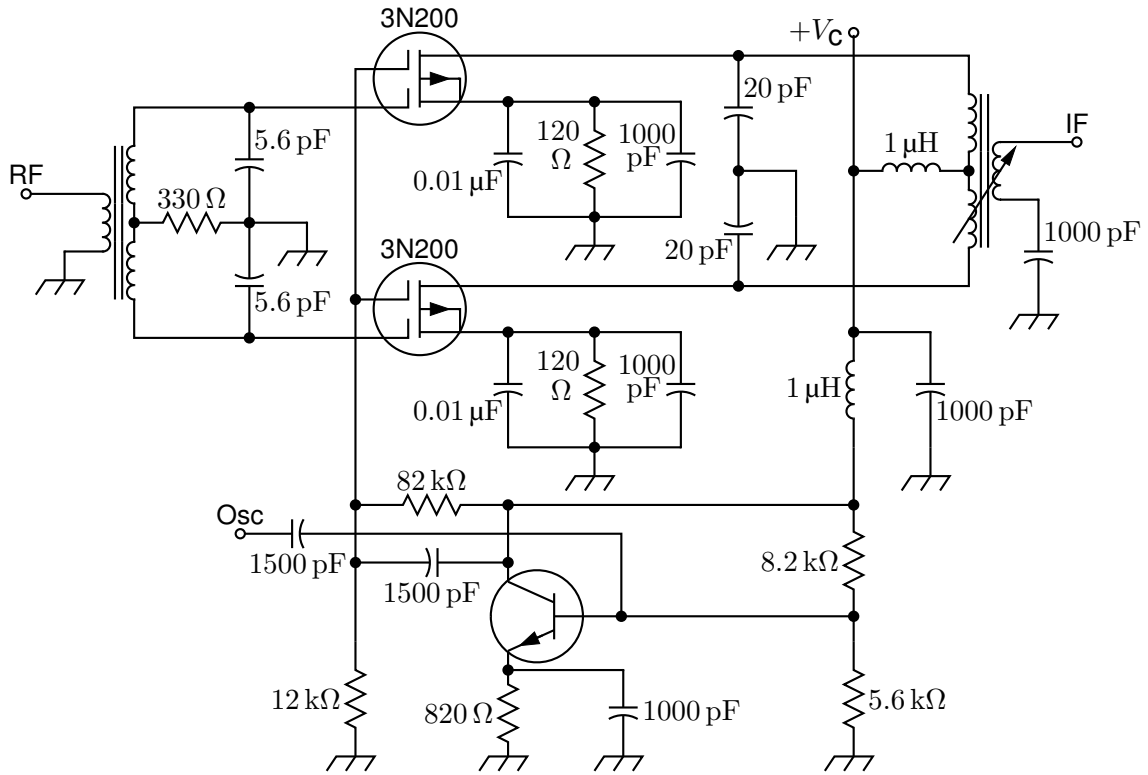


Figure 46: A push-pull mixer, showing FETs with multiple gates [PushPull.m4].

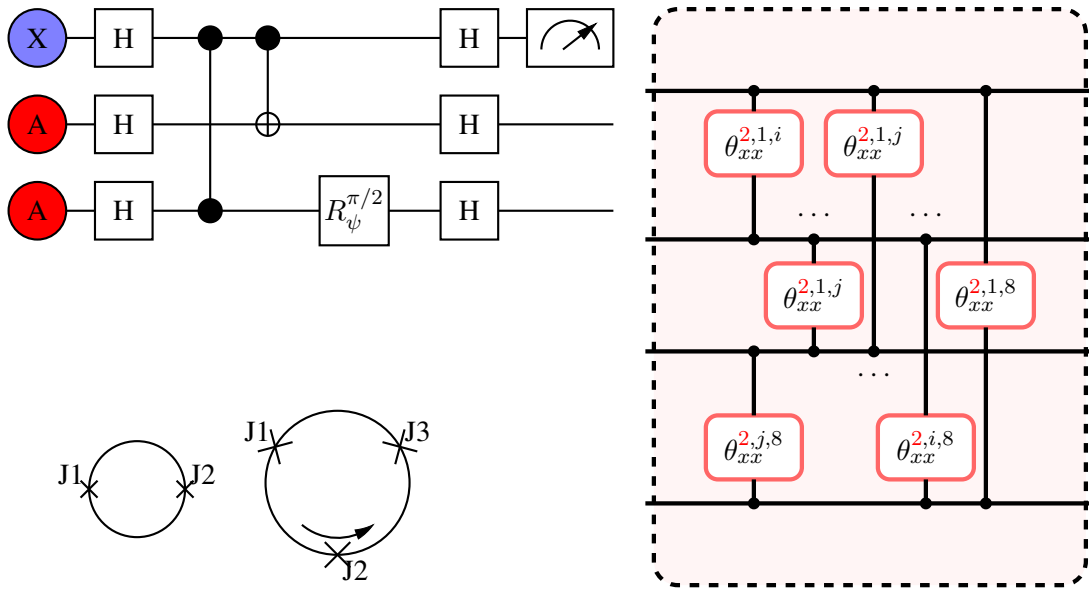


Figure 47: Quantum circuits [Quantum.m4].

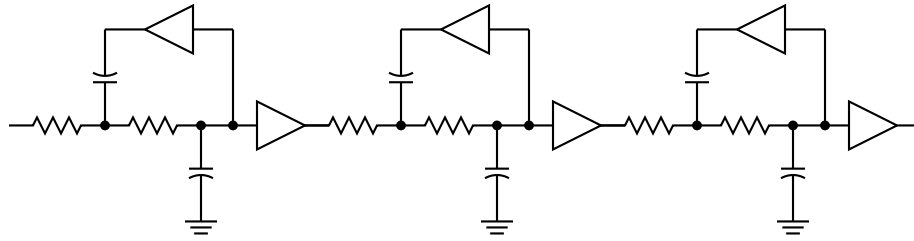


Figure 48: A six-pole filter [Sixpole.m4].

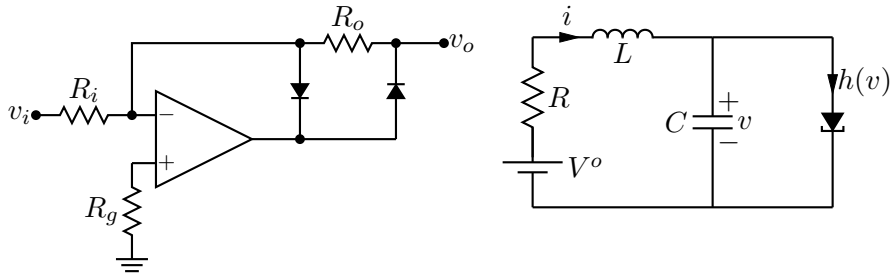


Figure 49: Precision half-wave rectifier and a tunnel diode circuit (illustrating opamp, diode, resistor, ground, and labels) [ex18.m4].

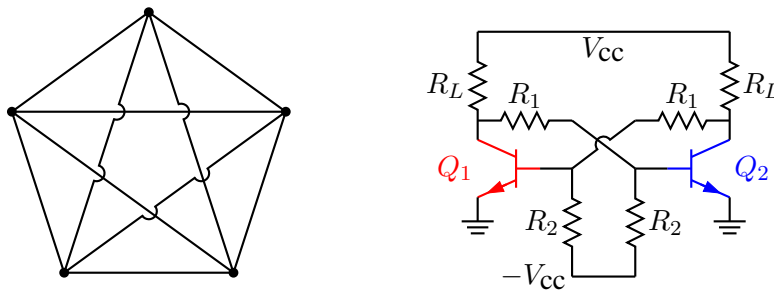


Figure 50: Non-planar graph and bistable circuit (illustrating the crossover macro and colored elements) [ex10.m4].

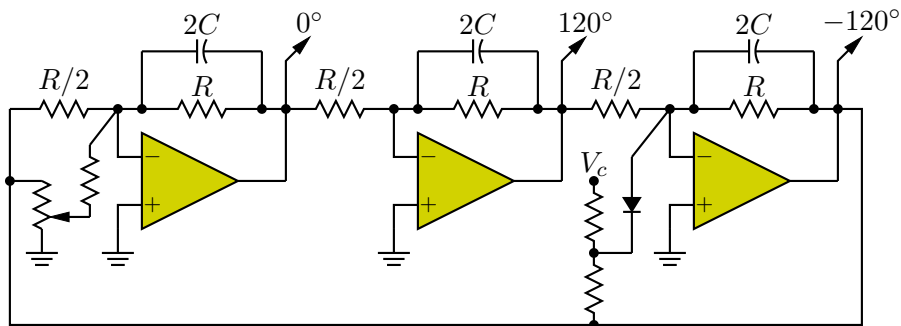


Figure 51: Three-phase oscillator [Three.m4].

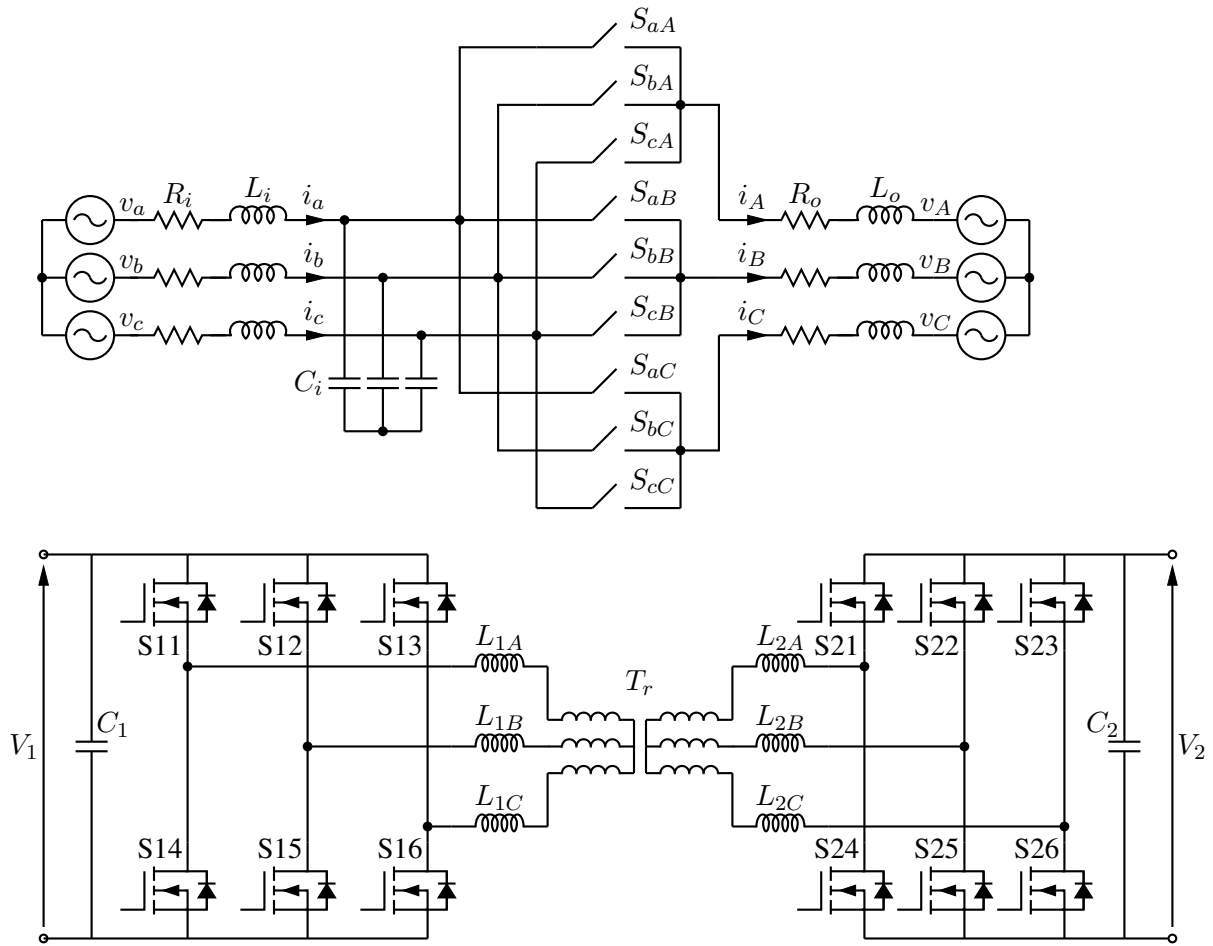


Figure 52: A three-phase switched AC-AC converter and a DC-DC converter [MC.m4].

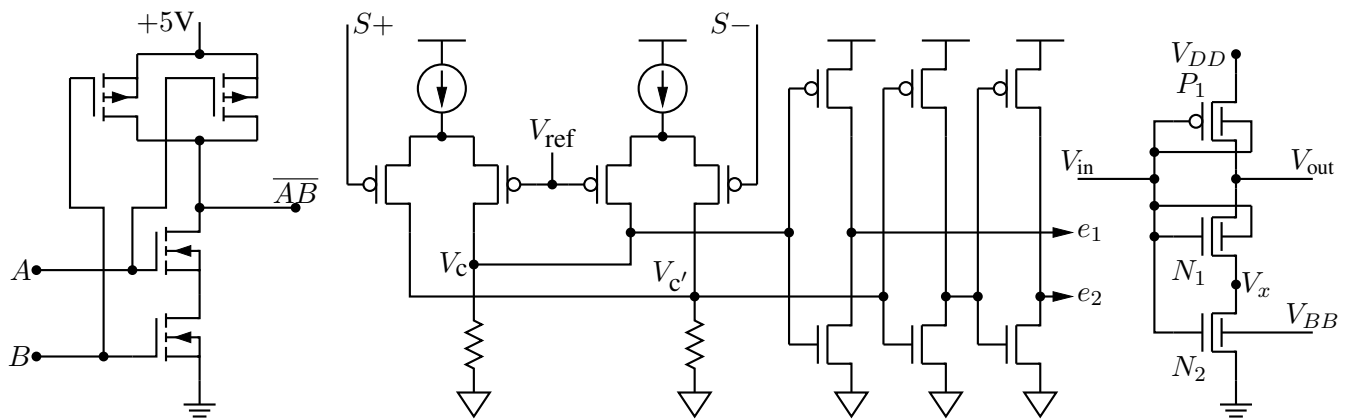


Figure 53: A CMOS NAND gate, a test circuit, and an XMOFET example [ex12.m4].

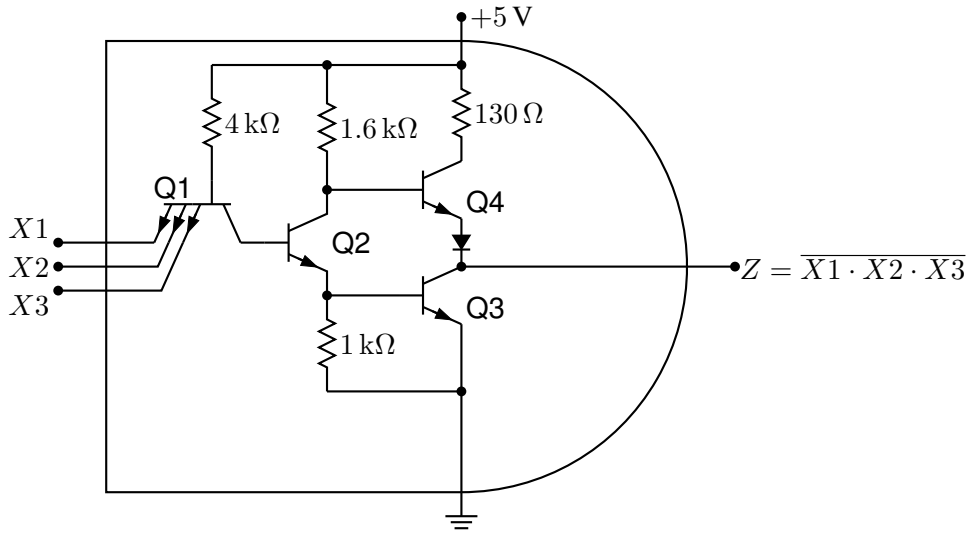


Figure 54: TTL NAND gate illustrating a transistor with multiple emitters [TTLnand.m4].

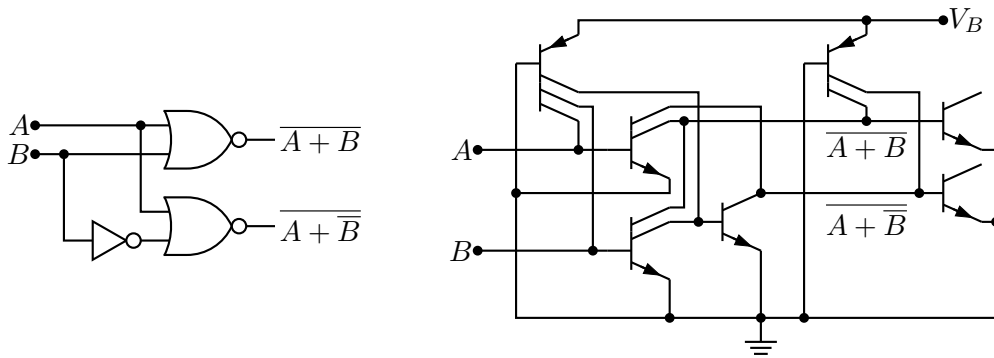


Figure 55: Gate circuit and equivalent embedded I^2L components illustrating multiple collectors [I2L.m4].

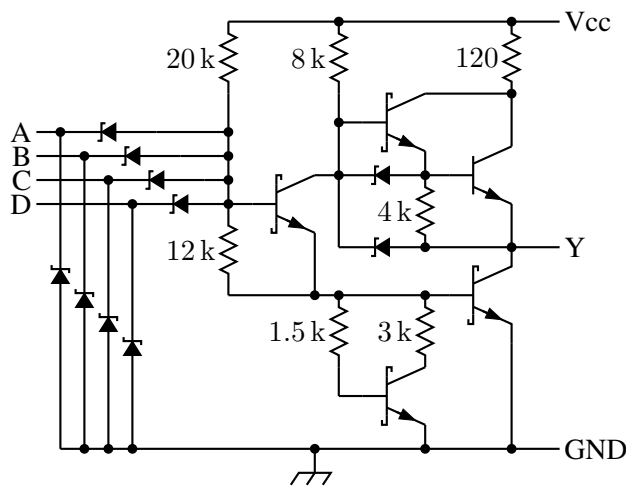


Figure 56: A 4-input NAND circuit illustrating the S (Schottky) option of bi_trans [Schottky.m4].

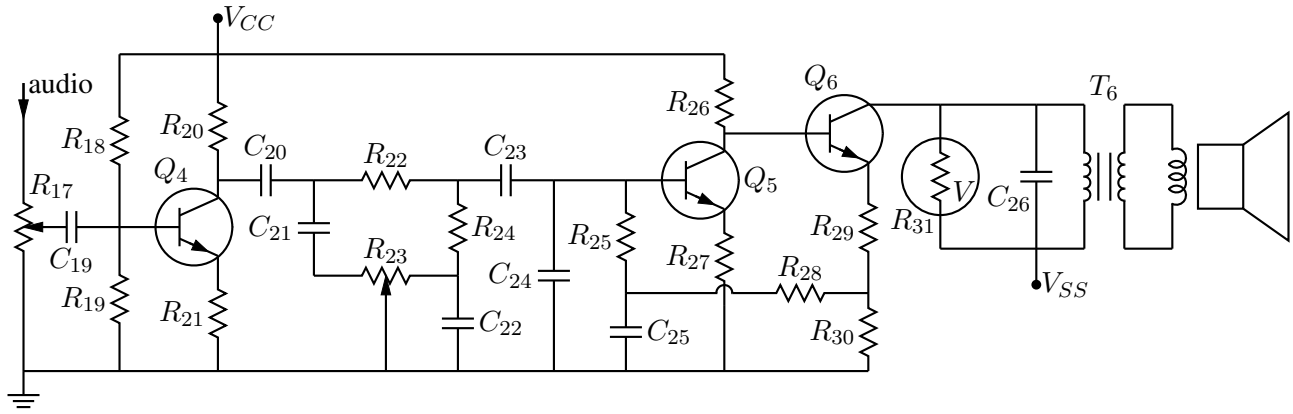


Figure 57: Transistor radio audio chain [ex11.m4].

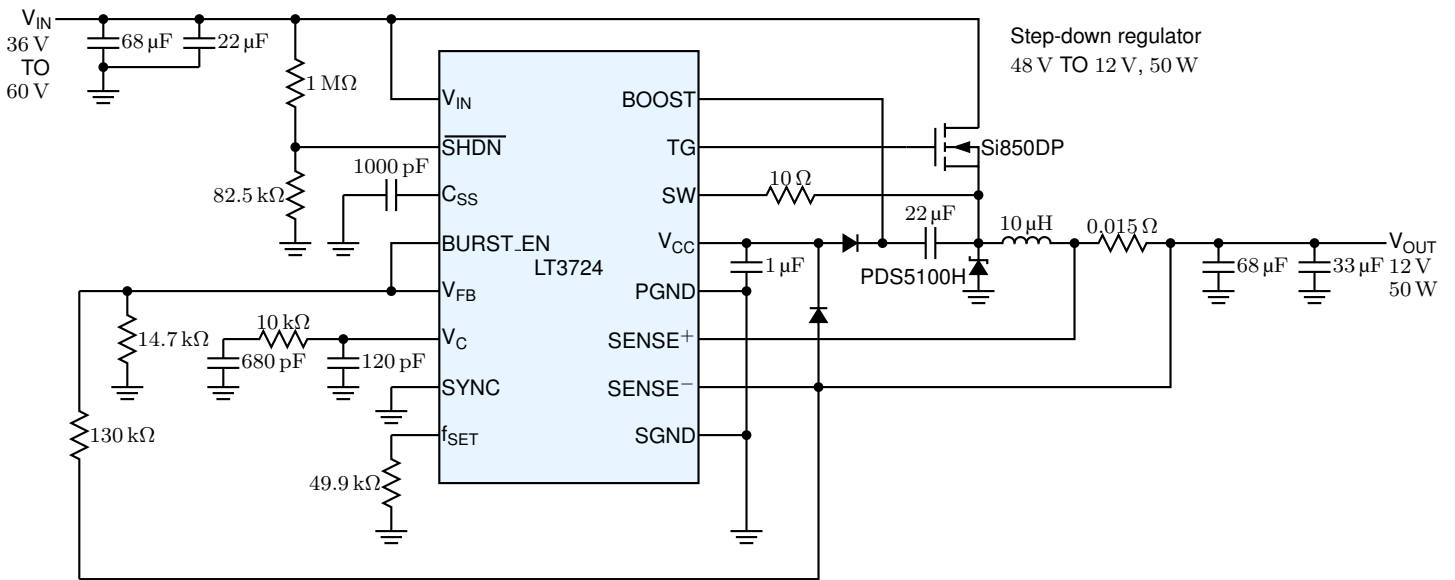


Figure 58: IC controller and auxiliary elements of a step-down converter [LT3524.m4].

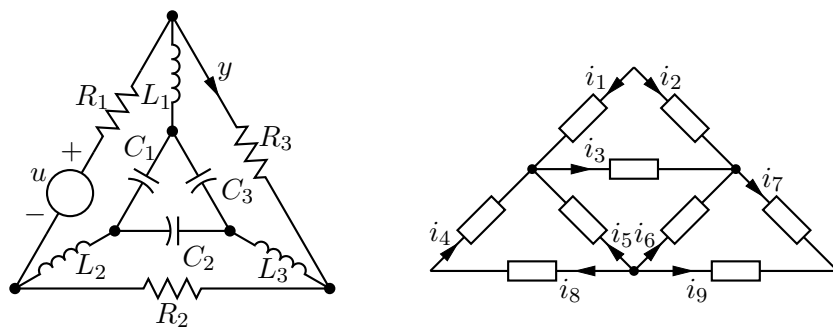


Figure 59: Labels on non-manhattan elements [ex04.m4].

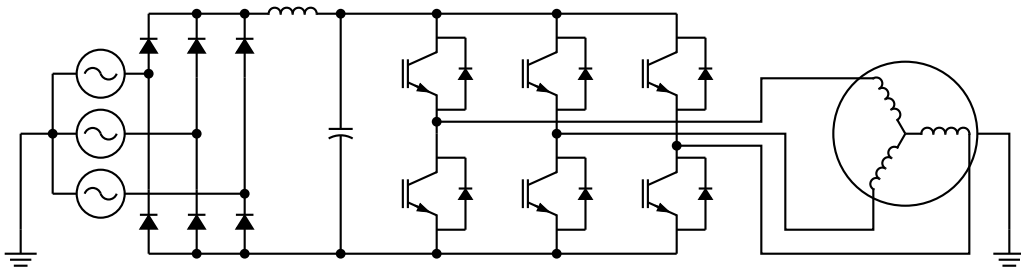


Figure 60: Synchronous machine driven by variable-speed drive and rectifier [Drive.m4].

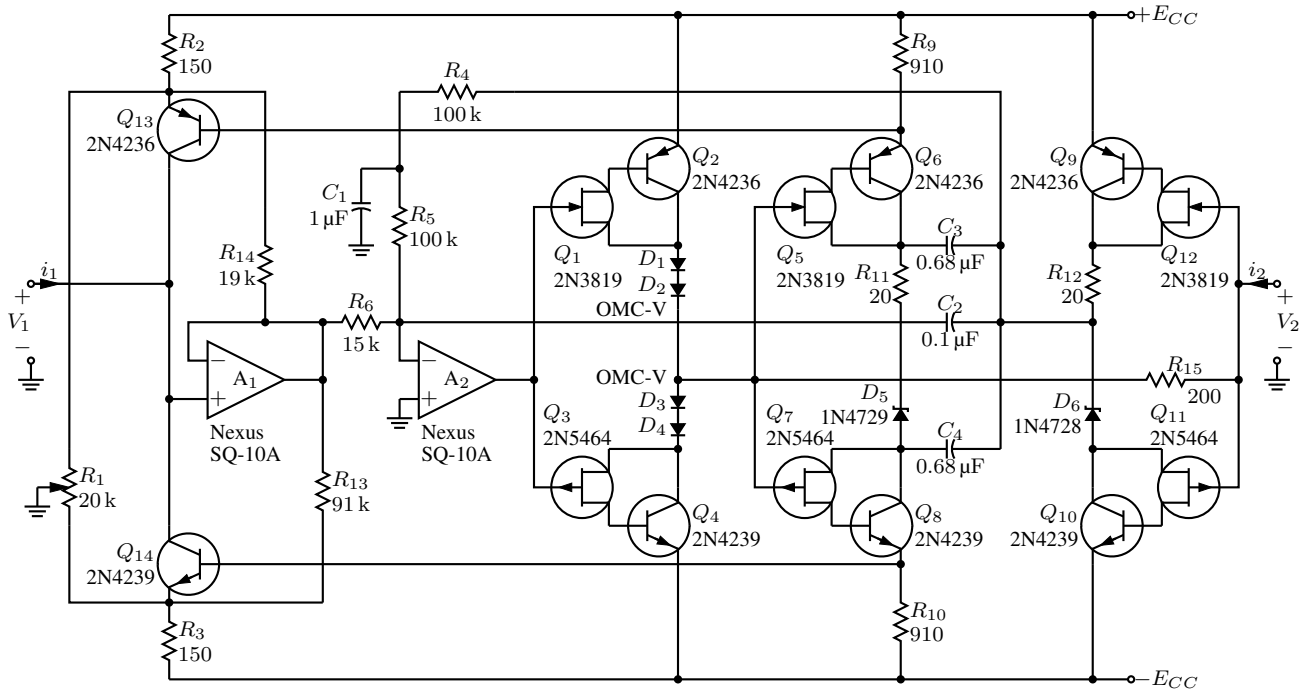


Figure 61: Realization of a controlled source (illustrating stacked element labels) [Csource.m4].

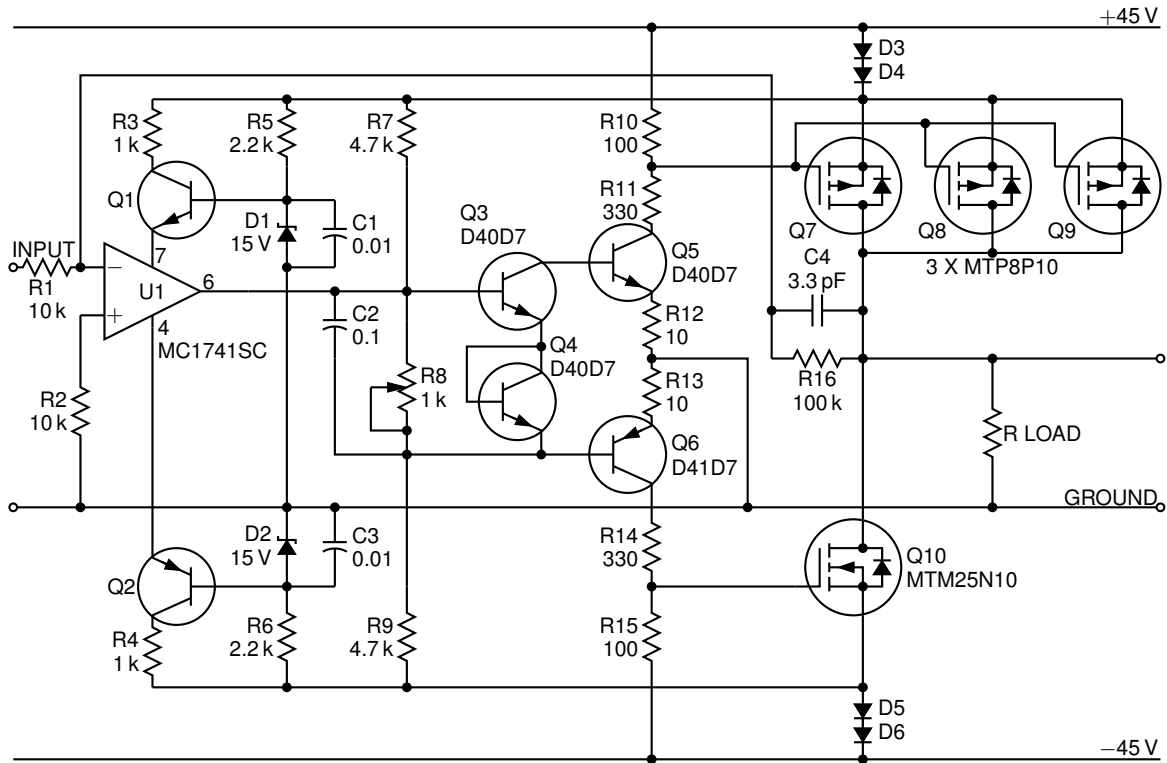


Figure 62: A 50 W audio amplifier [AudioAmp.m4].

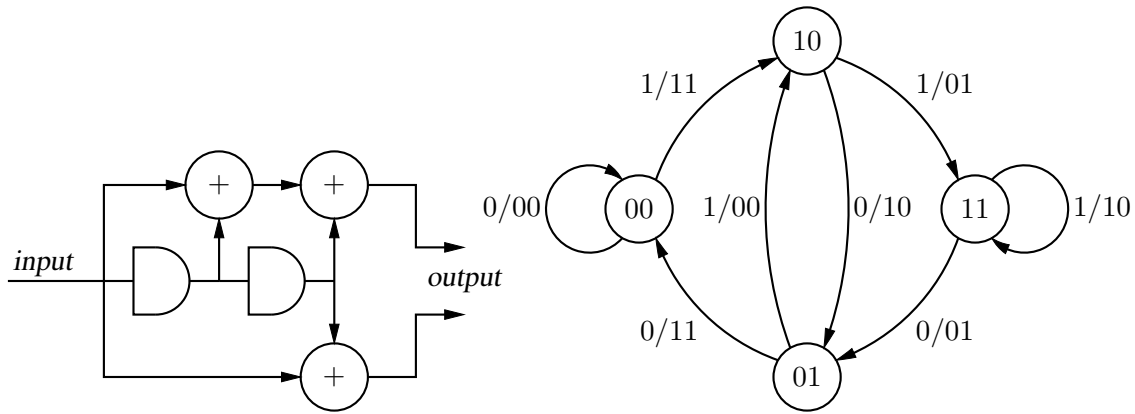


Figure 63: A rate 1/2 binary convolutional coder and its state diagram [ex16.m4].

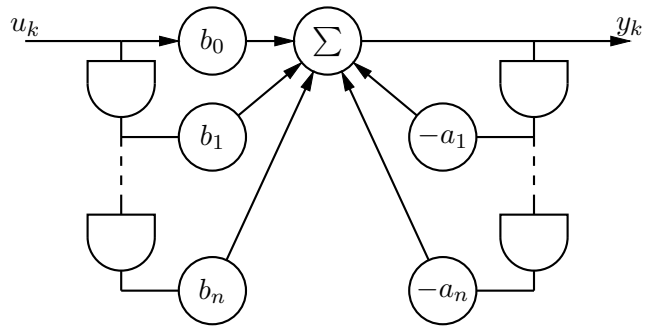


Figure 64: Digital filter [ex03.m4].

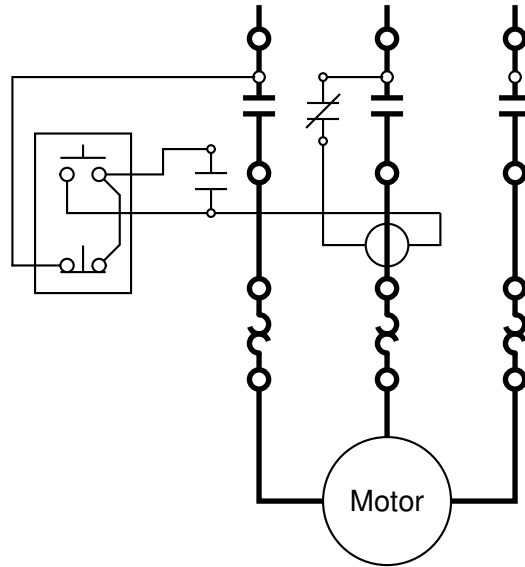


Figure 65: Motor control connections [MotorControl.m4].

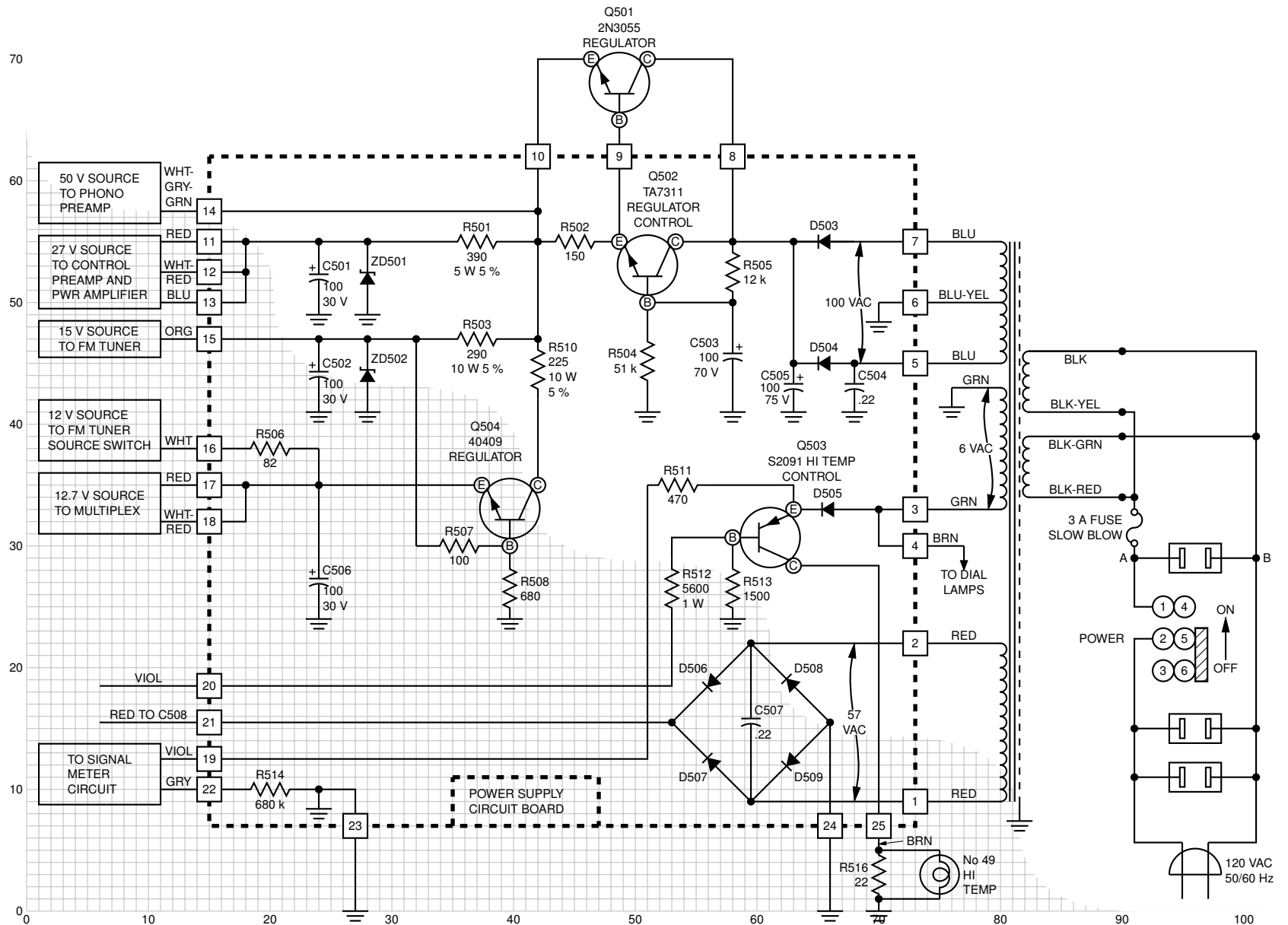


Figure 66: The power supply of a Heathkit AR-15 (Now, *that* was a receiver!) with custom transformer and other elements, drawn on a grid (partially shown) to aid in placement [Heathkit.m4].

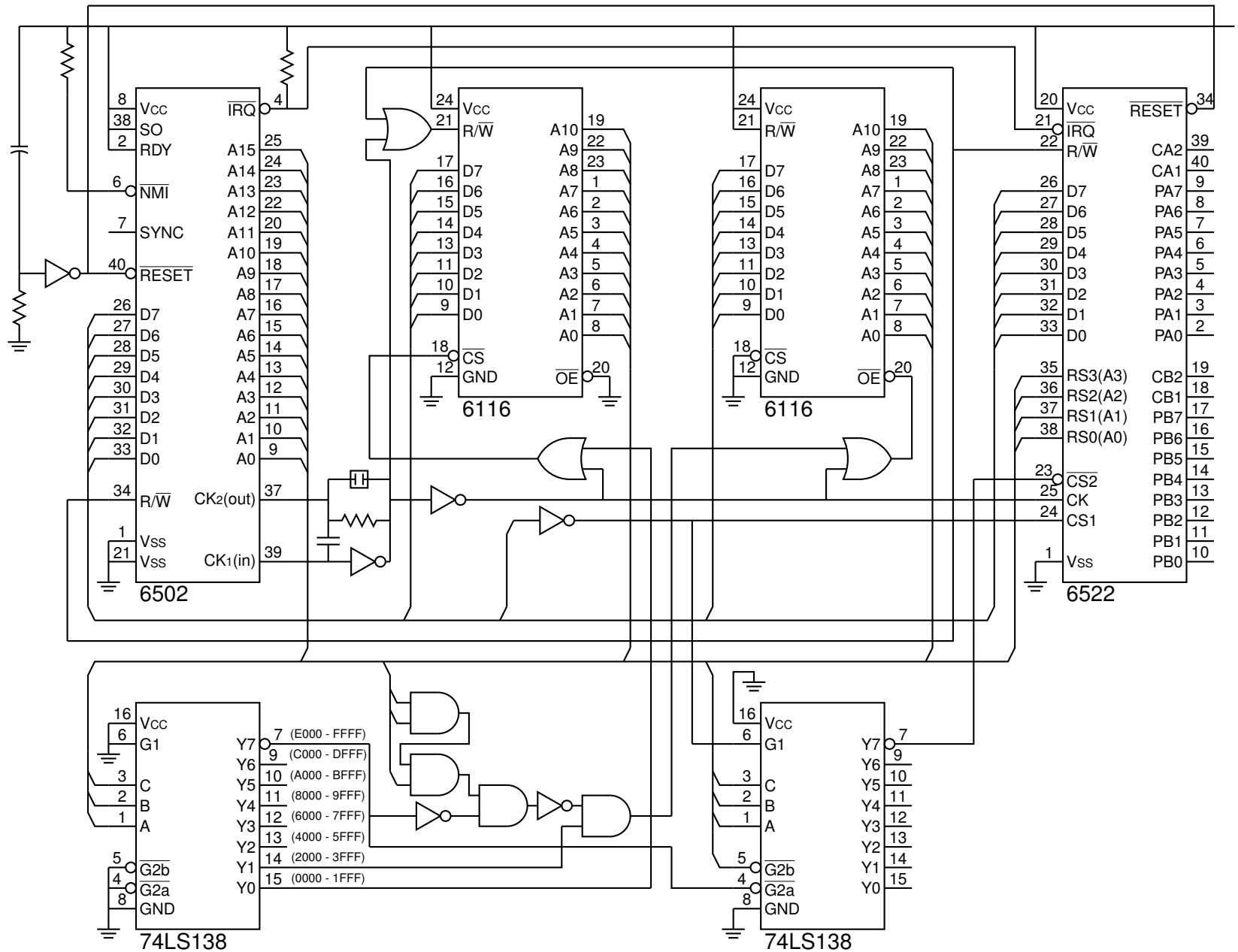


Figure 67: A digital circuit of moderate size, redrawn from M. P. Maclenan and G. M. Burns, "An Approach to Drawing Circuit Diagrams for Text Books," Tugboat (12)1, March 1991, pp. 66-69 [lcct.m4].

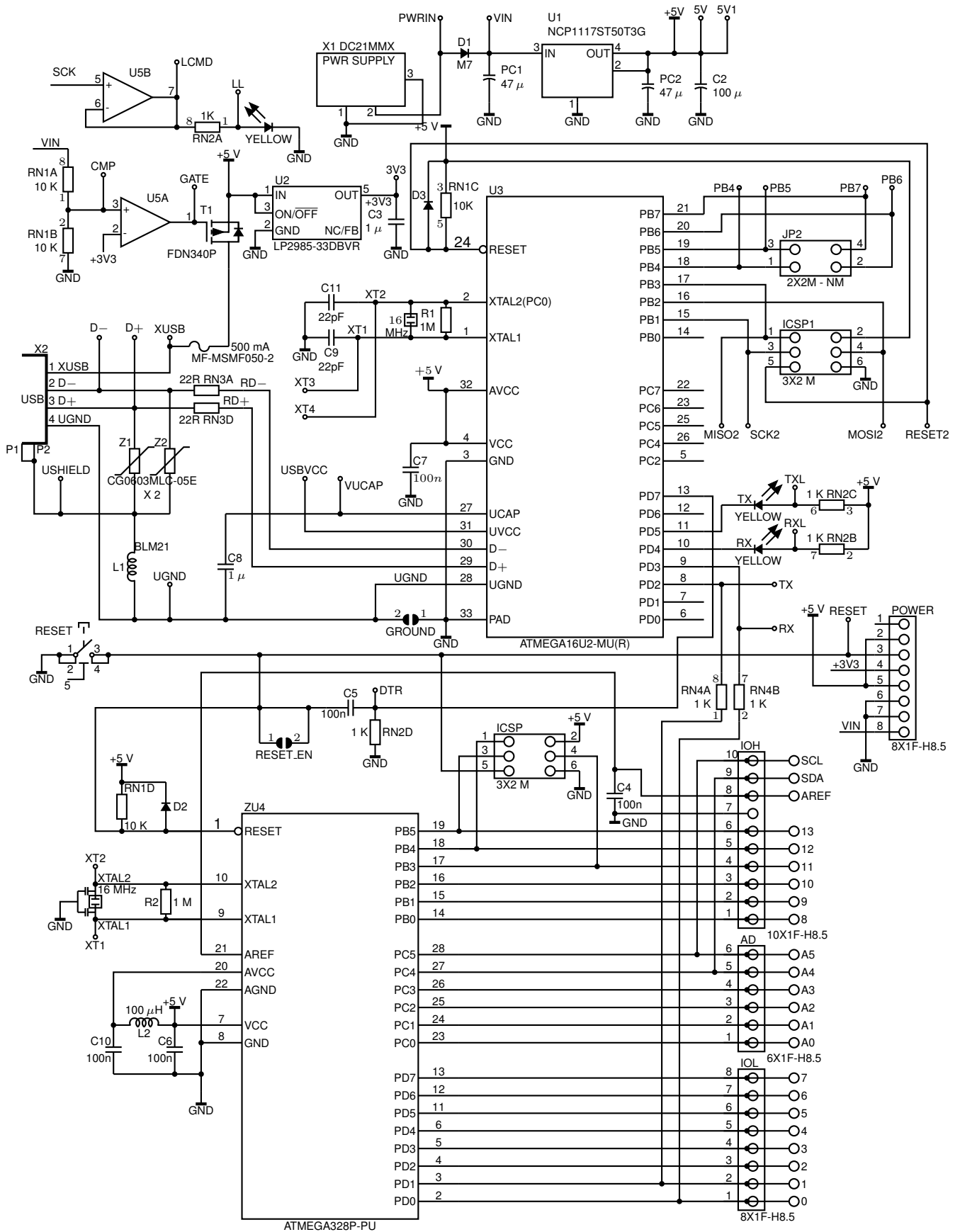


Figure 68: An Arduino UNO circuit adapted and redrawn [UNO .m4].

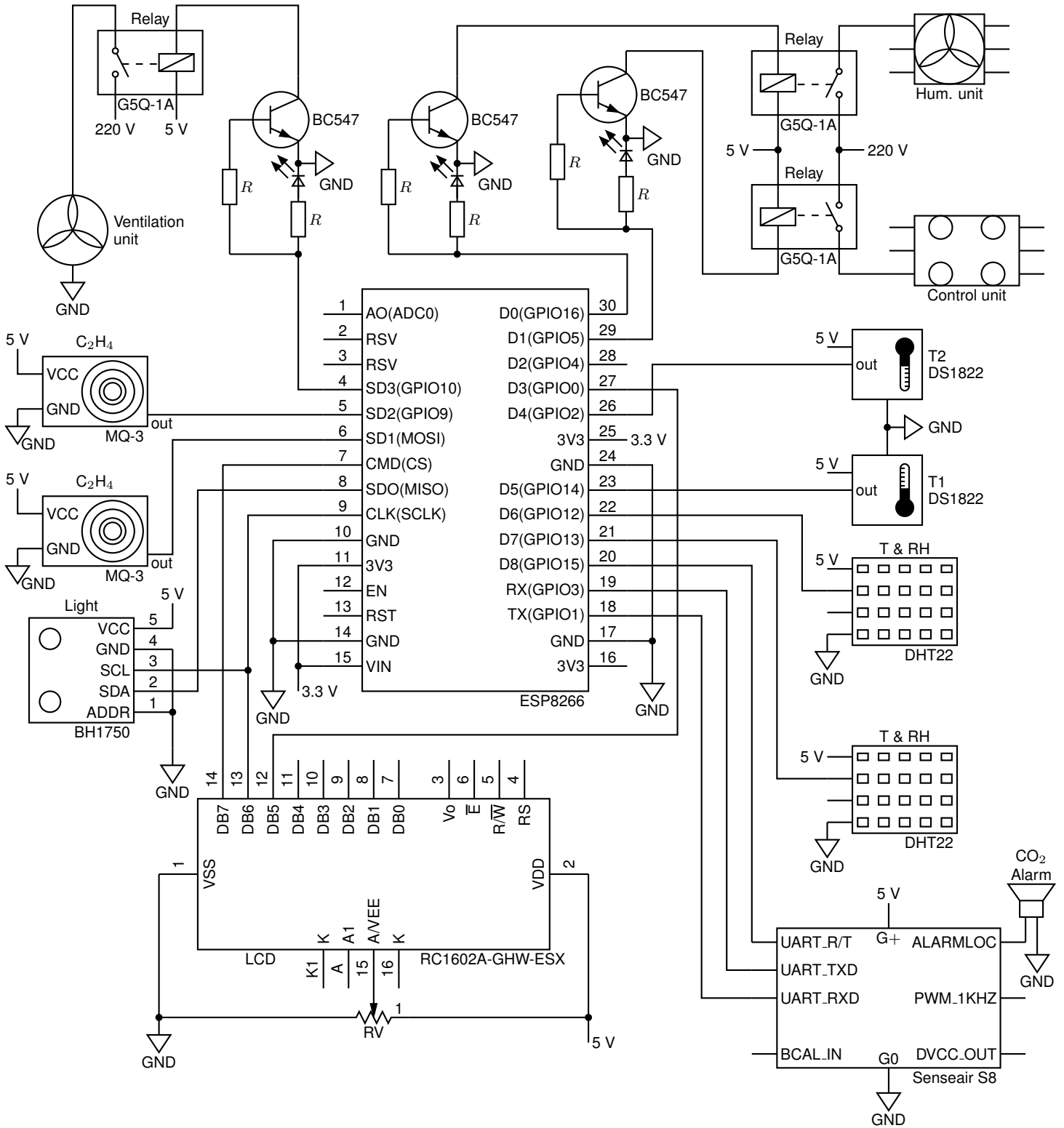


Figure 69: Part of a cold room controller, with some custom sensors [ColdControl1.m4].

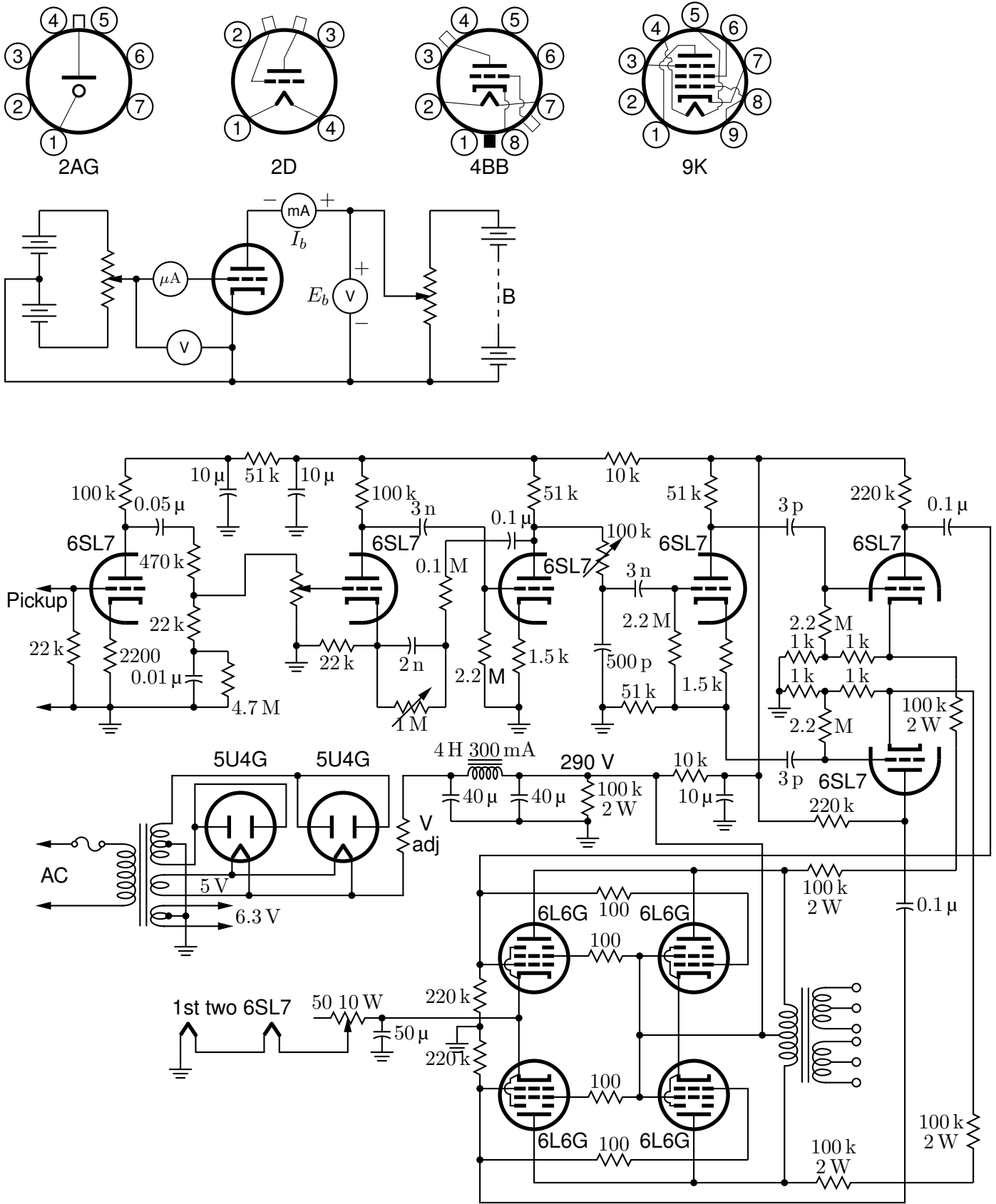


Figure 70: Electron-tube diagrams: a few bottom-view base diagrams, a generic triode test circuit, and a 25-watt audio amplifier adapted from F. Langford-Smith, *Radiotron Designer's Handbook*, fourth edition, Harrison, NJ: Radio Corporation of America, 1952 [Tubediags.m4].

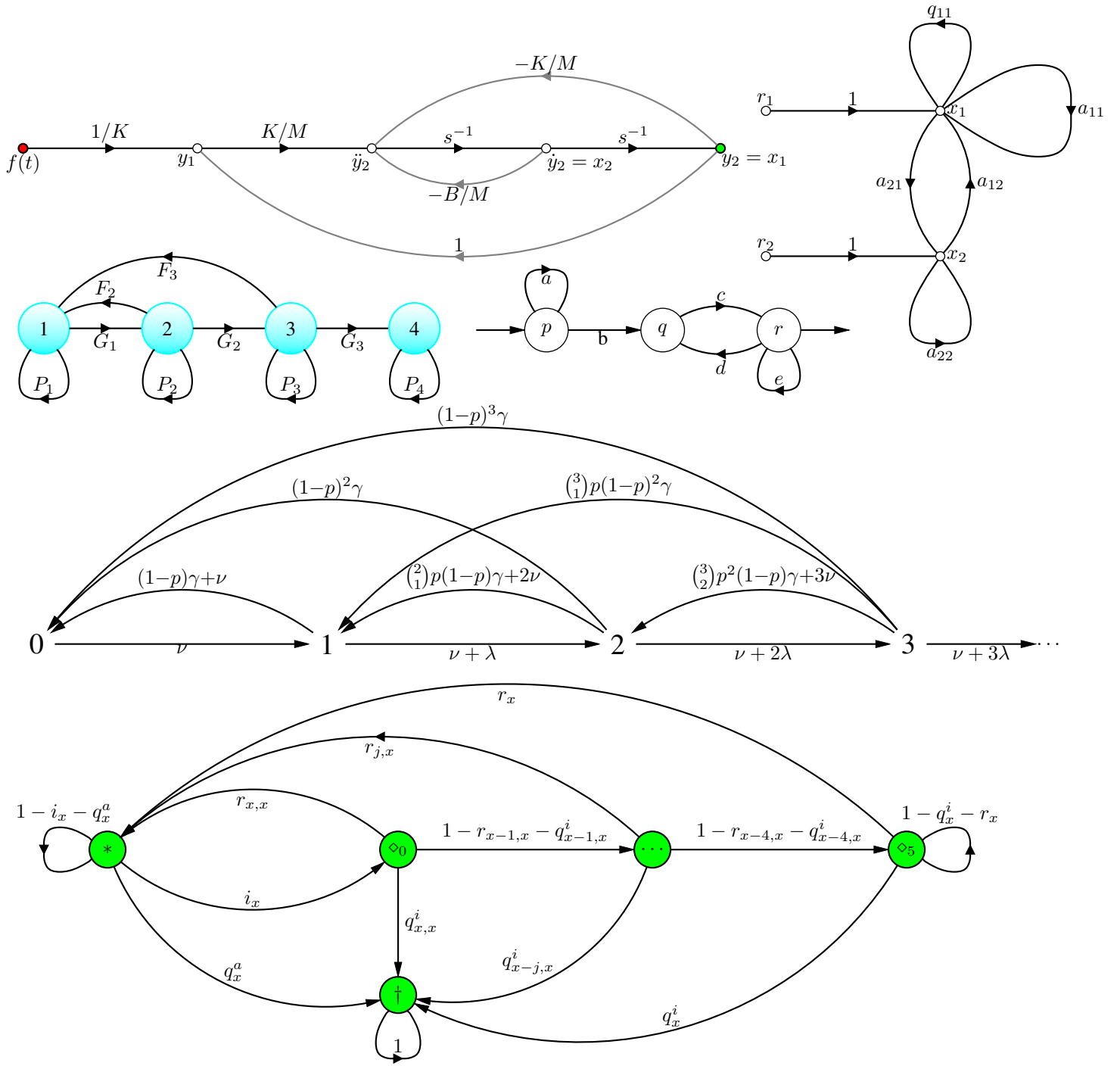


Figure 71: Signal-flow graphs [sfg.m4].

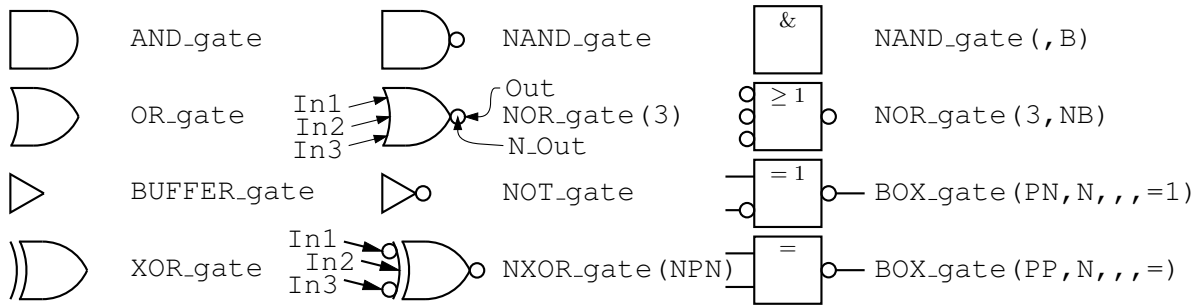


Figure 72: Basic logic gates [Logic.m4].

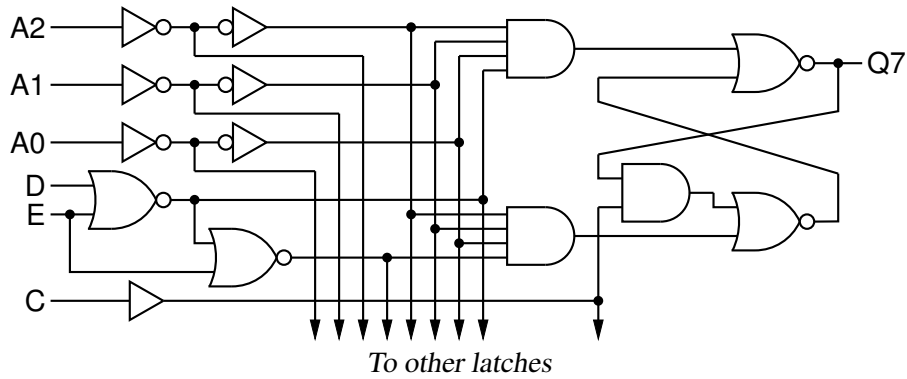


Figure 73: General-purpose latch: a small logic circuit [ex08.m4].

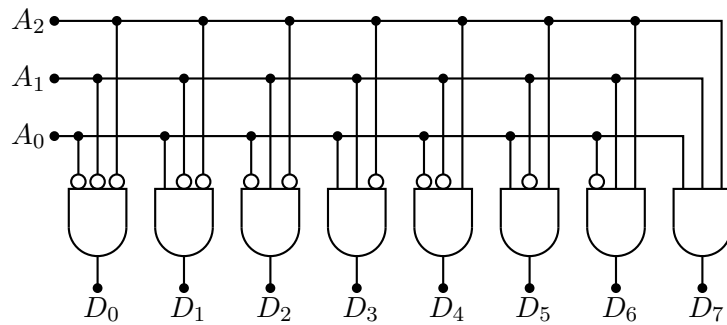


Figure 74: Decoder logic, constructed using the for_macro [Decoder.m4].

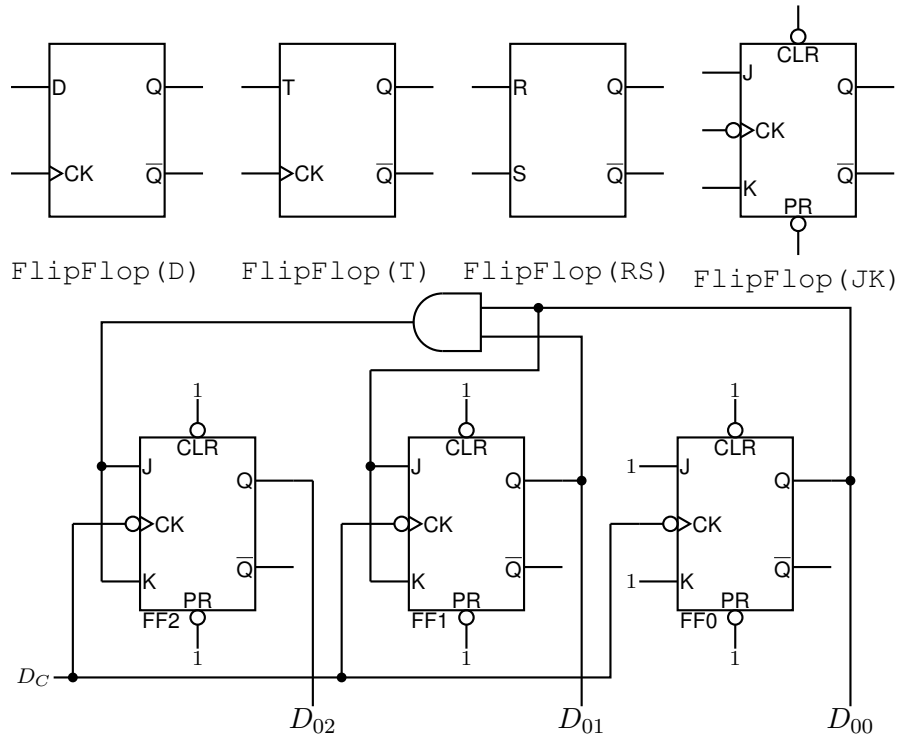


Figure 75: Some flip-flops [ex21.m4].

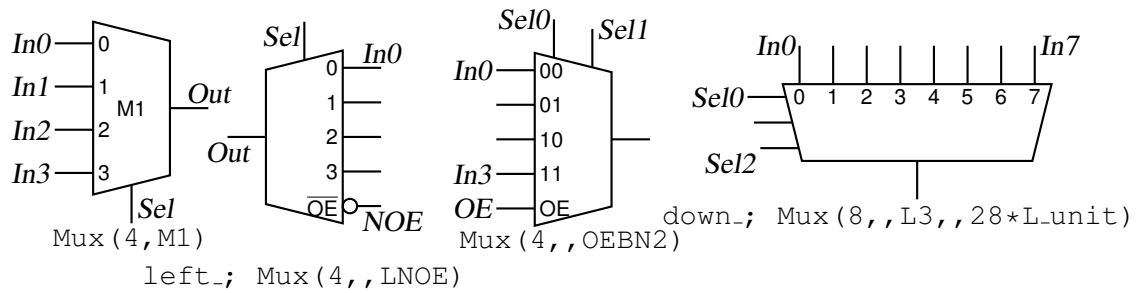


Figure 76: Multiplexer [Multiplexer.m4].

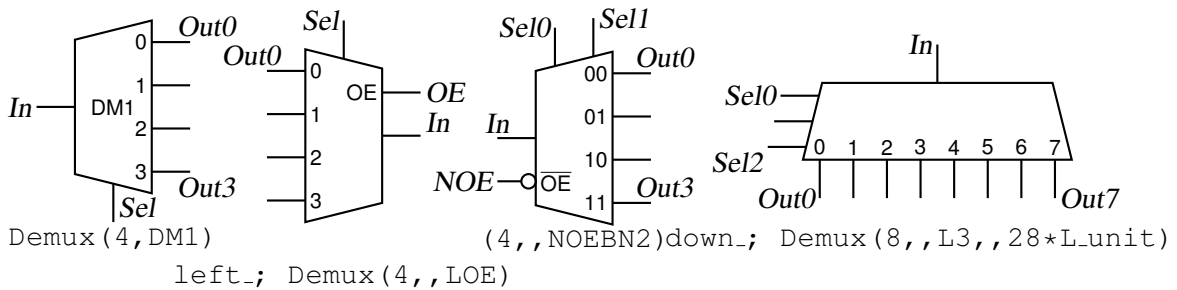


Figure 77: Demultiplexer [Demultiplexer.m4].

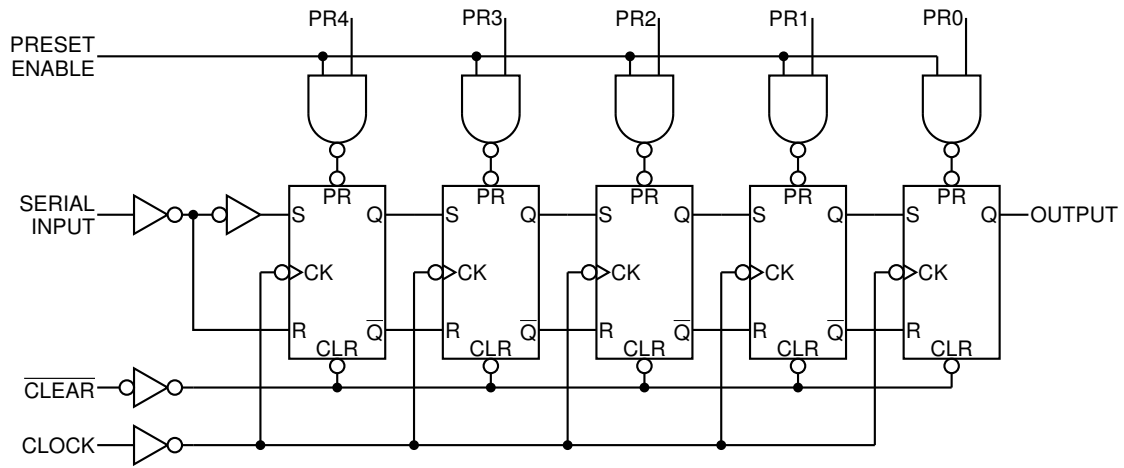


Figure 78: A 5-bit shift register drawn using a custom flip-flop [ShiftR.m4].

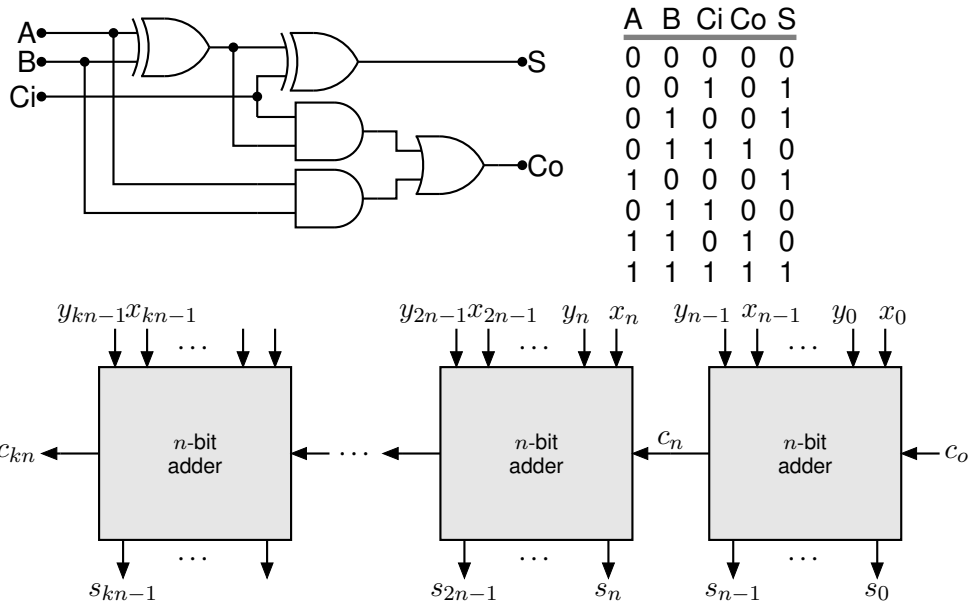
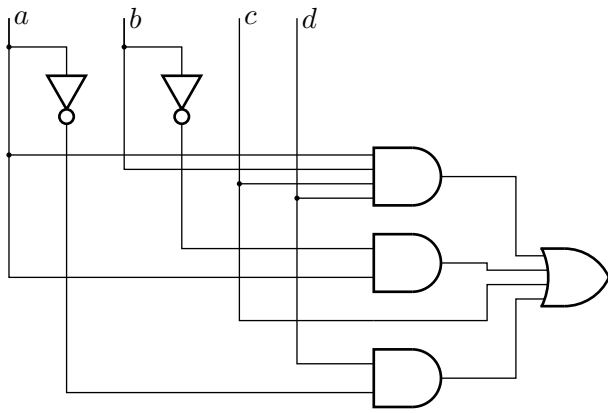
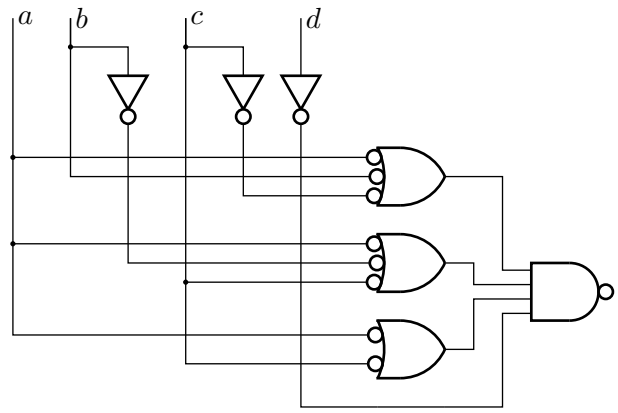


Figure 79: A full adder and a cascade of n -bit adders [Adder.m4].



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



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

Figure 80: A way of automatically drawing two-layer logic diagrams [CanLogic.m4].

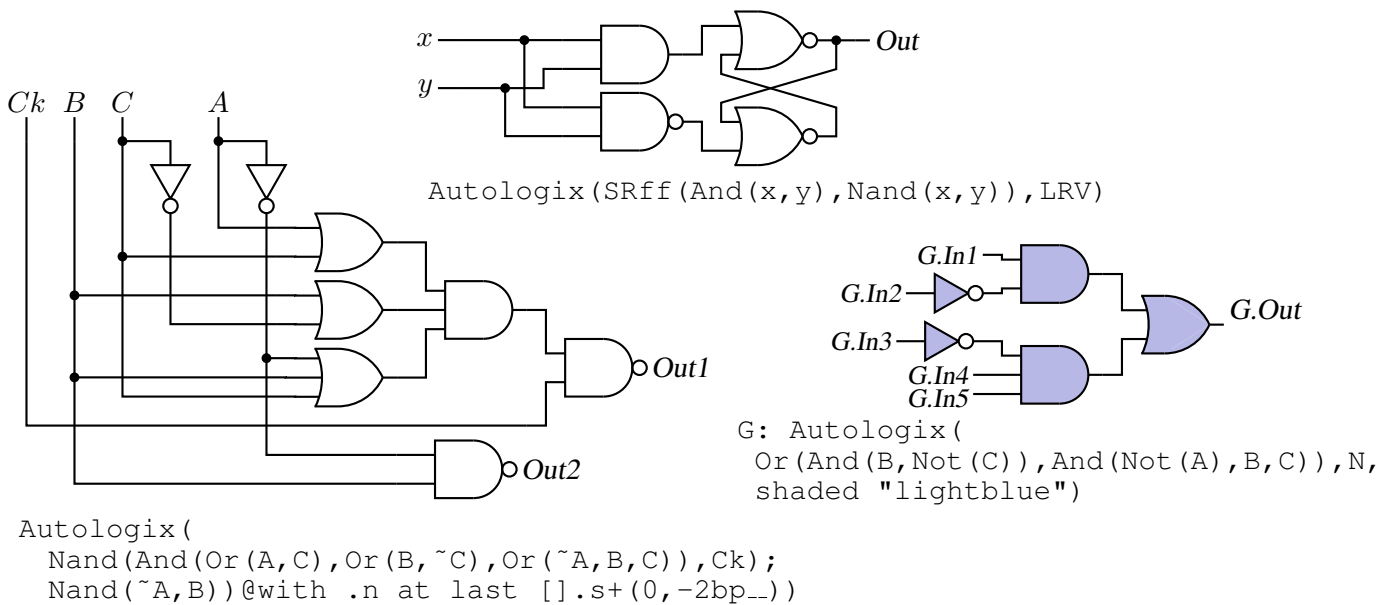
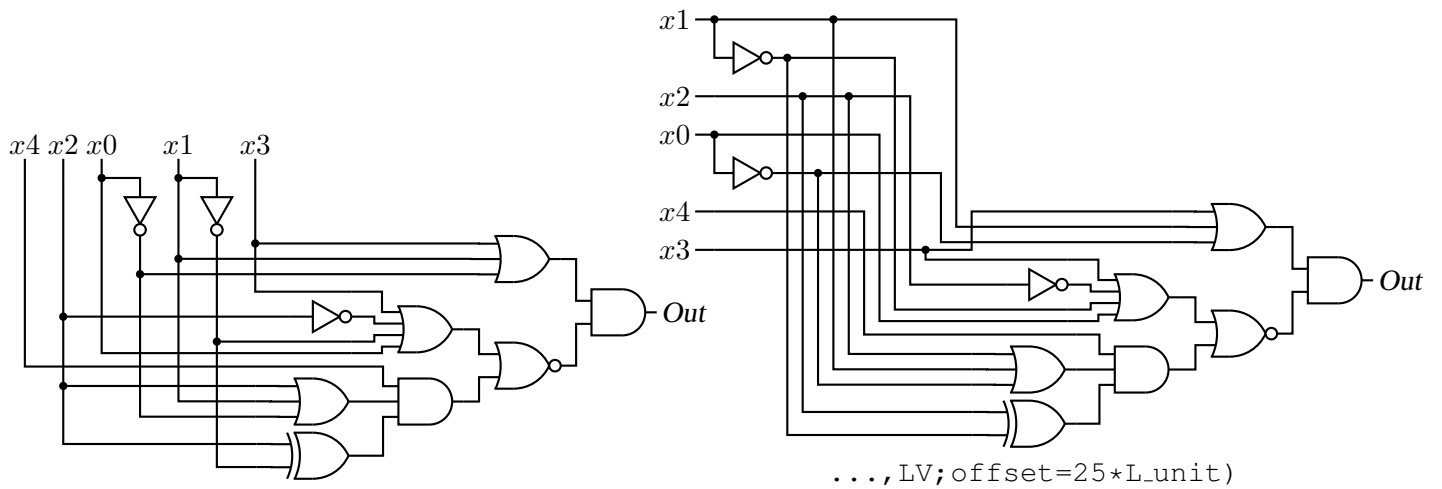


Figure 81: The Autologix (Boolean expression; Boolean expression... , options) macro automatically draws Boolean expressions in function notation. The function tree is drawn, then a row or column of inputs, then the connections. The default result is on the left, a custom element at the top, and a tree 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))))))
```

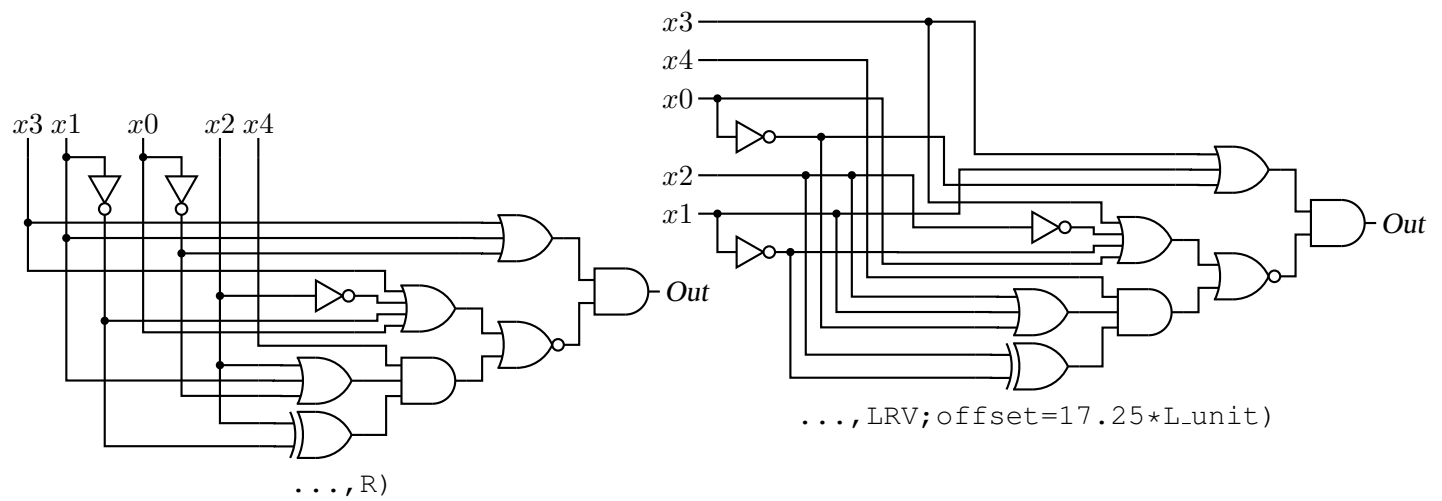


Figure 82: The Autologix macro can draw inputs on the left but the added drawing complexity may require hand tuning with second-argument options: L puts the inputs on the left, R reverses their order, V scans the input arguments in reverse order, and `offset=value` displaces the array of inputs [ABlogix.m4].

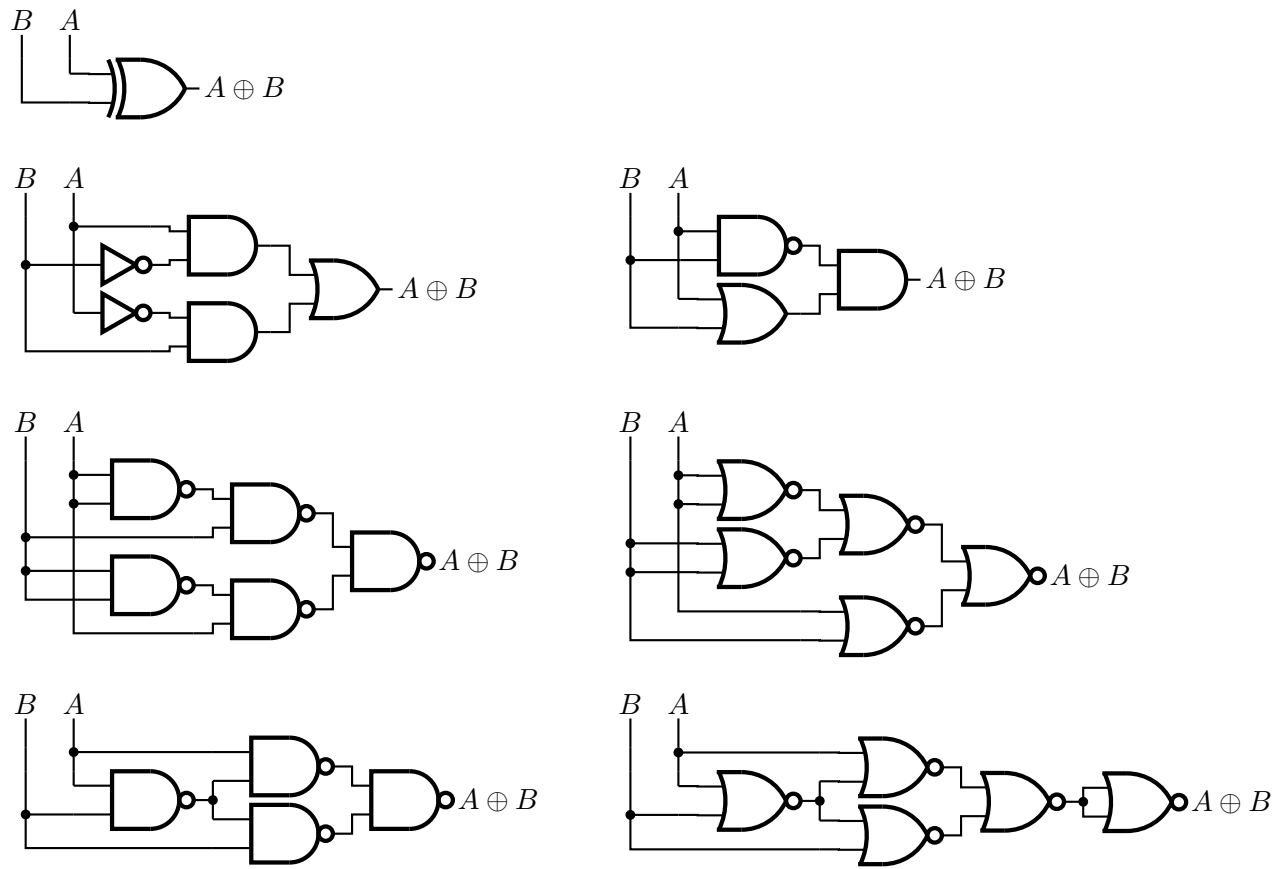


Figure 83: Realizations of the XOR function using Autologix [XOR.m4].

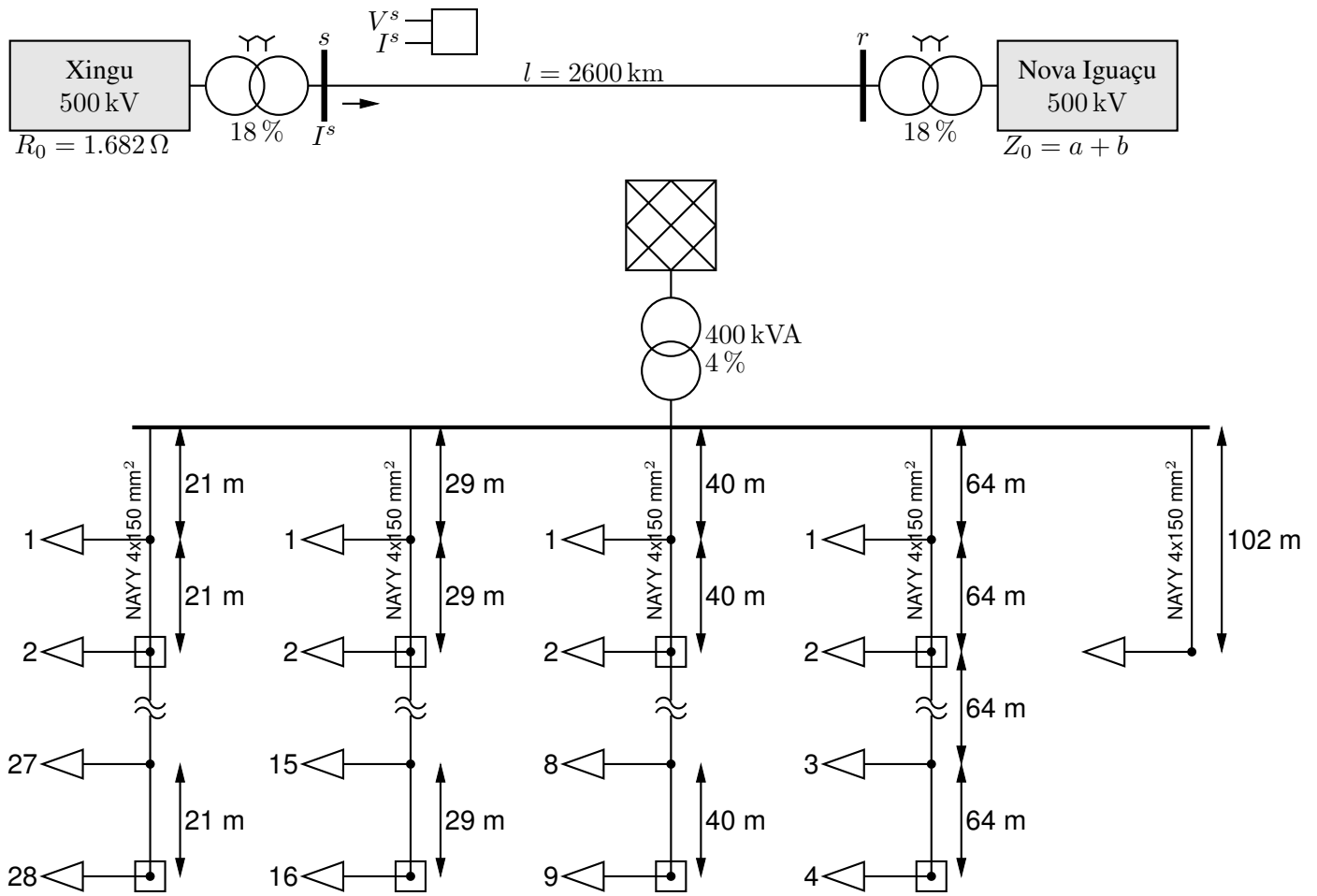


Figure 84: A single-line distribution diagram [OneLine.m4].

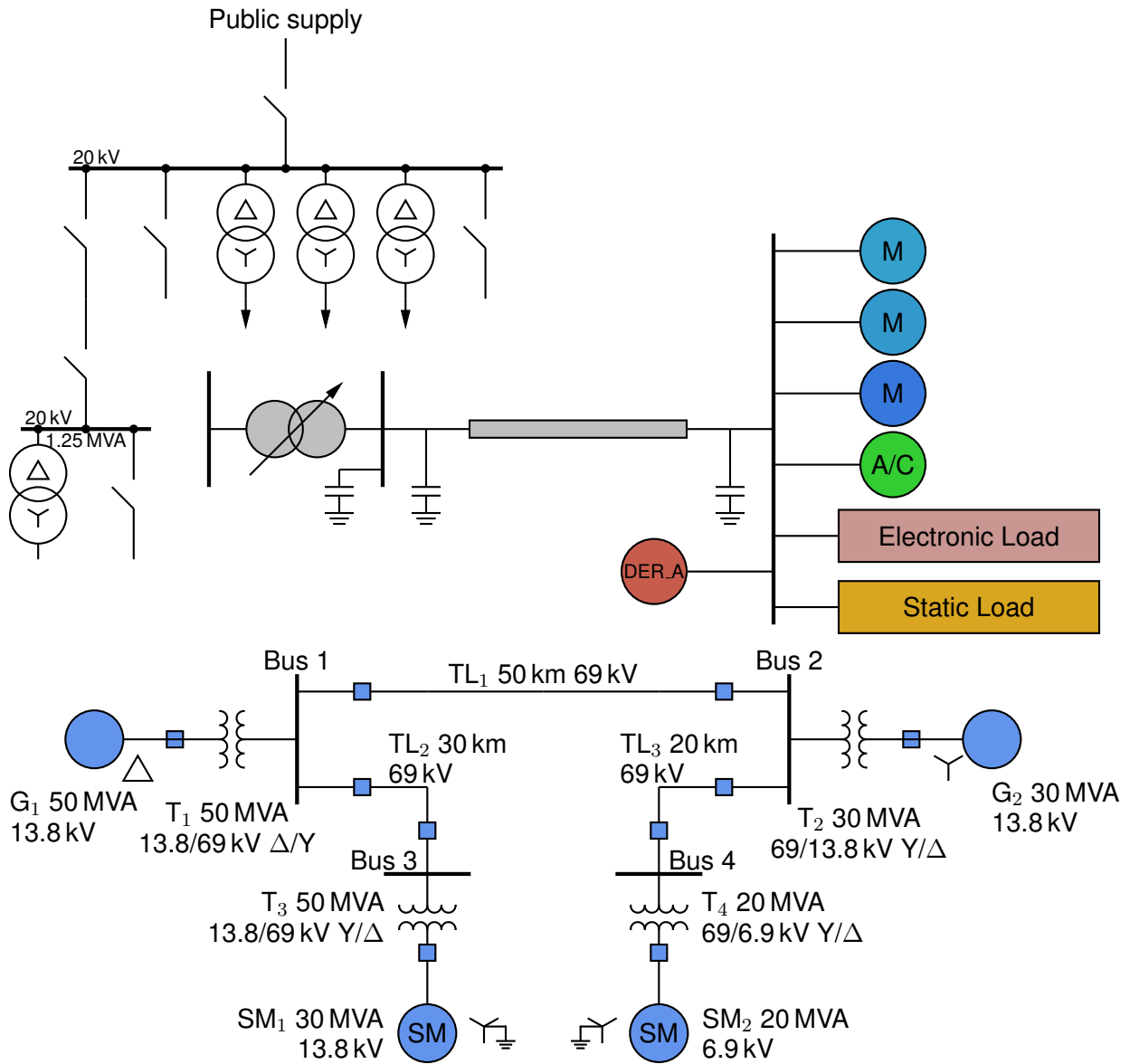


Figure 85: A further test of single-line diagram macros [EEP.m4].

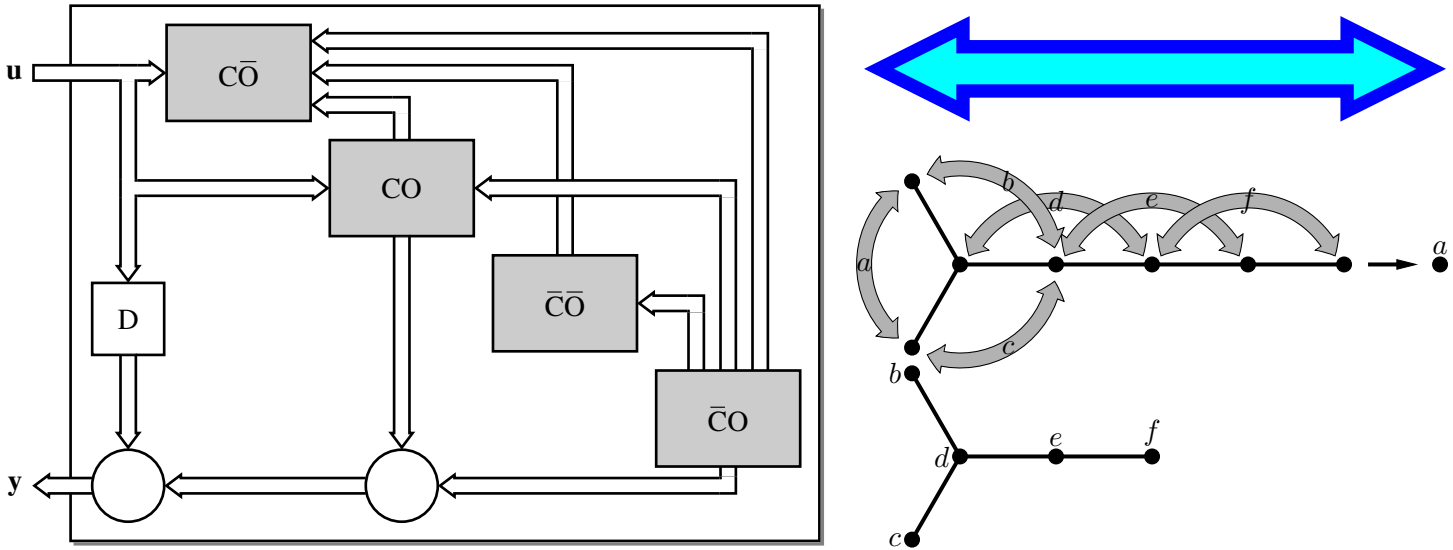


Figure 86: Use of darrow and Darc [ex05.m4].

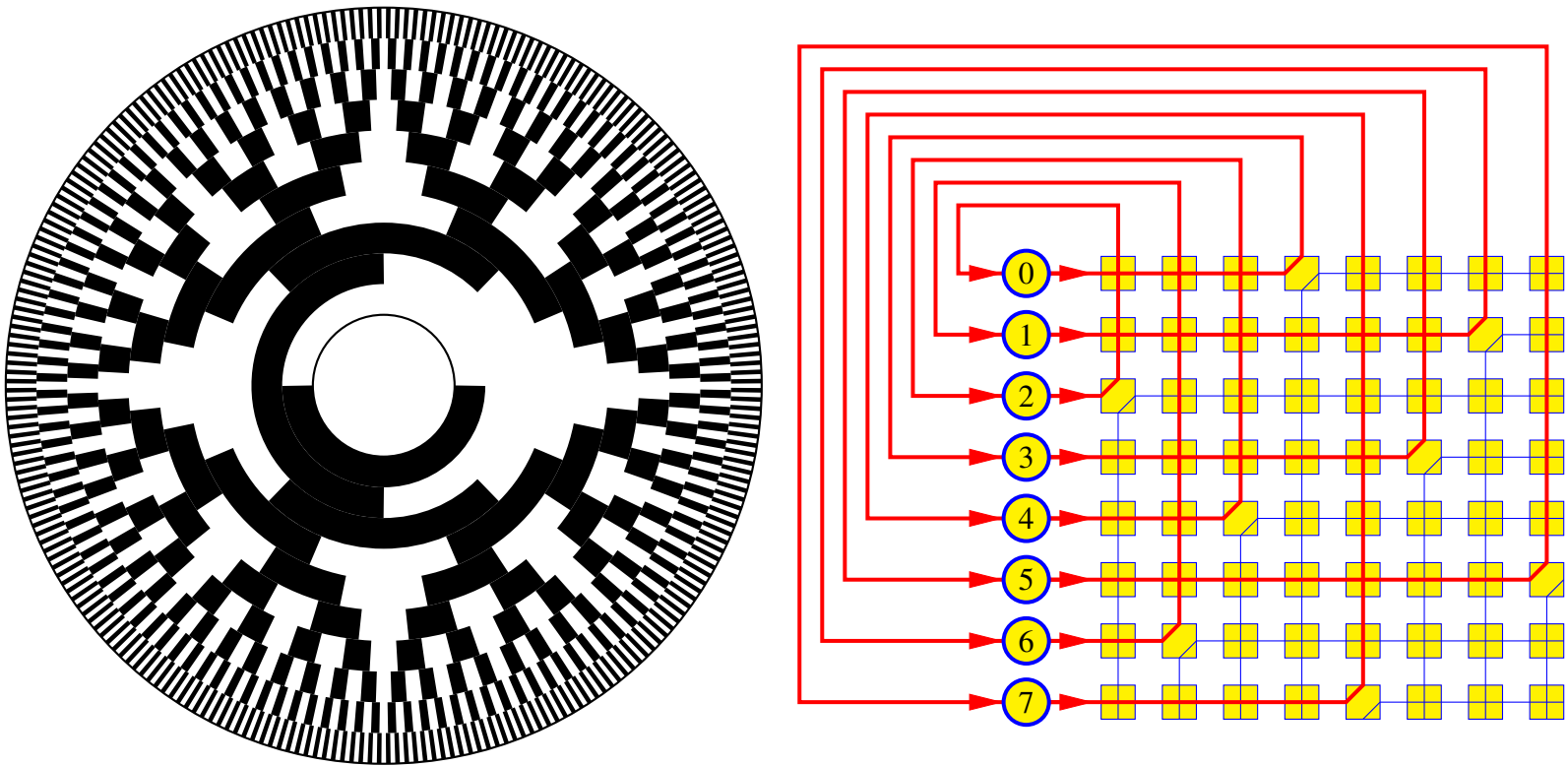
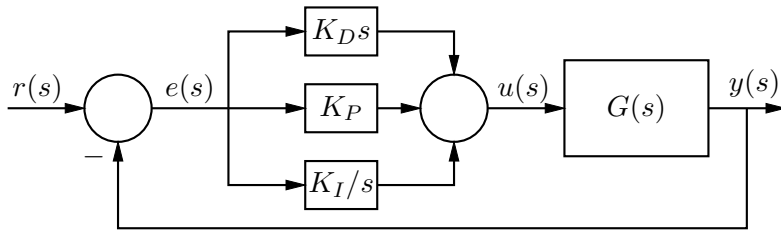
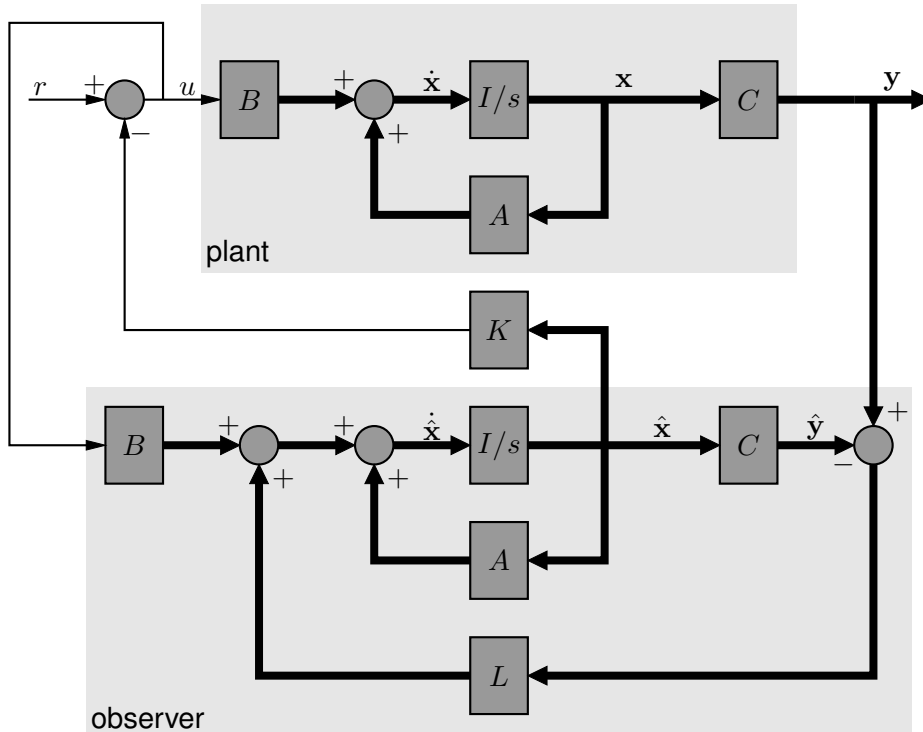


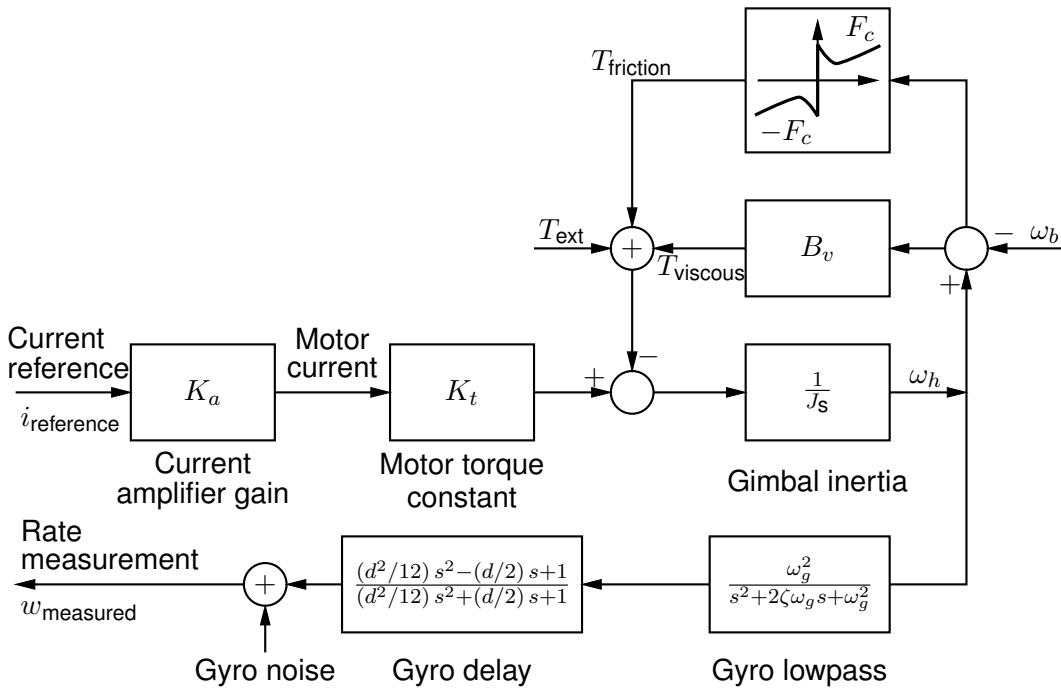
Figure 87: The power of looping and branching: Gray code 10-bit encoder disk pattern and a crossbar switch [GrayCode.m4].



(a) PID control



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



(d) Single-axis gimbal model

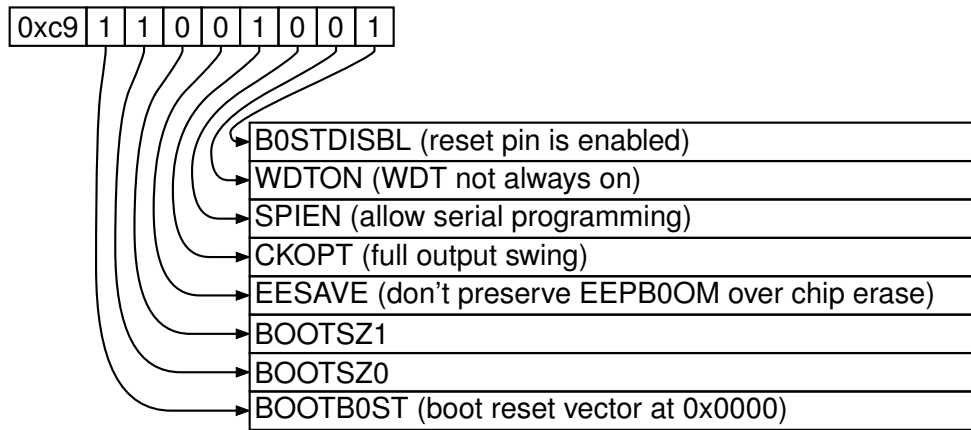


Figure 89: Elementary splines [Byte.m4].



Figure 90: A customizable seven-segment display showing the numbered segments, a custom shape, and the numerals from 0 to 9 [Sevenssegment.m4].

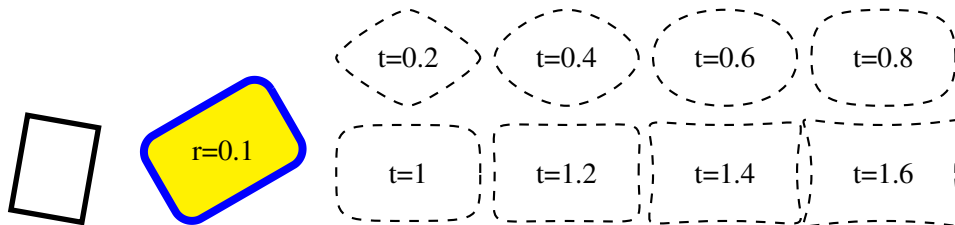


Figure 91: The macro `rotbox(wid,ht,type,[r|t=val])` draws a box in the current direction [Rotbox.m4].

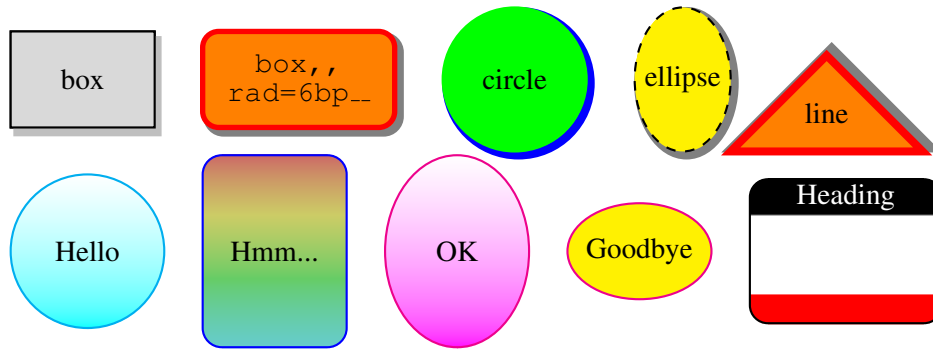


Figure 92: Embellishments: the top row illustrates `shadowed(box|circle|ellipse|line, [at position], keys)` and the second row `ColoredV(box|circle|ellipse, (r,g,b) | ((colorseq)), attributes)` [`Shadowed.m4`].

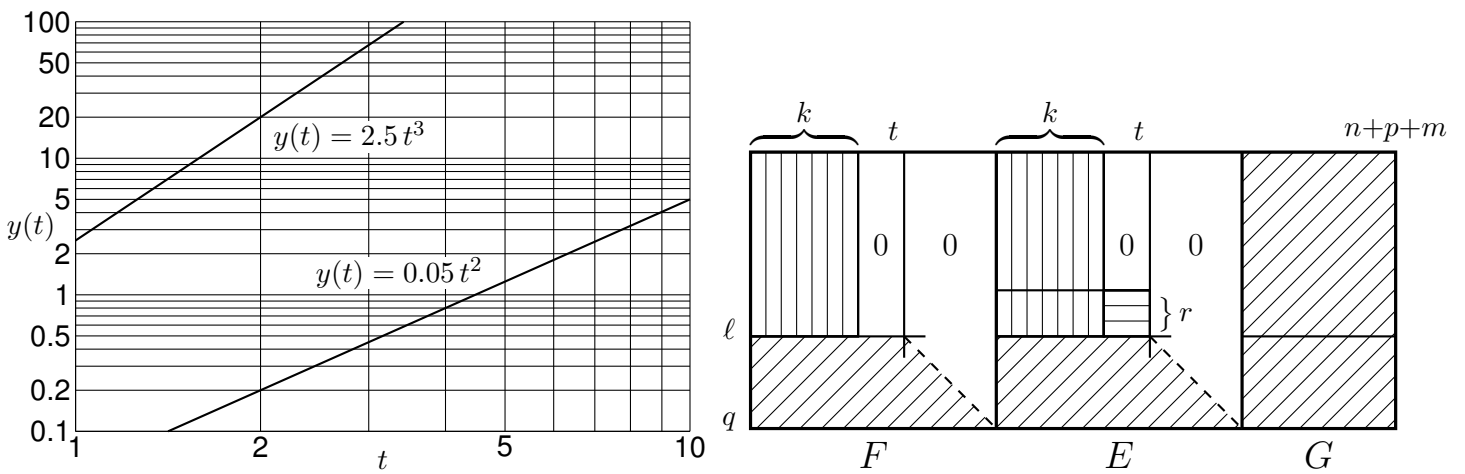


Figure 93: A graph and crosshatching example drawn using the pic language [`Loglog.m4`].

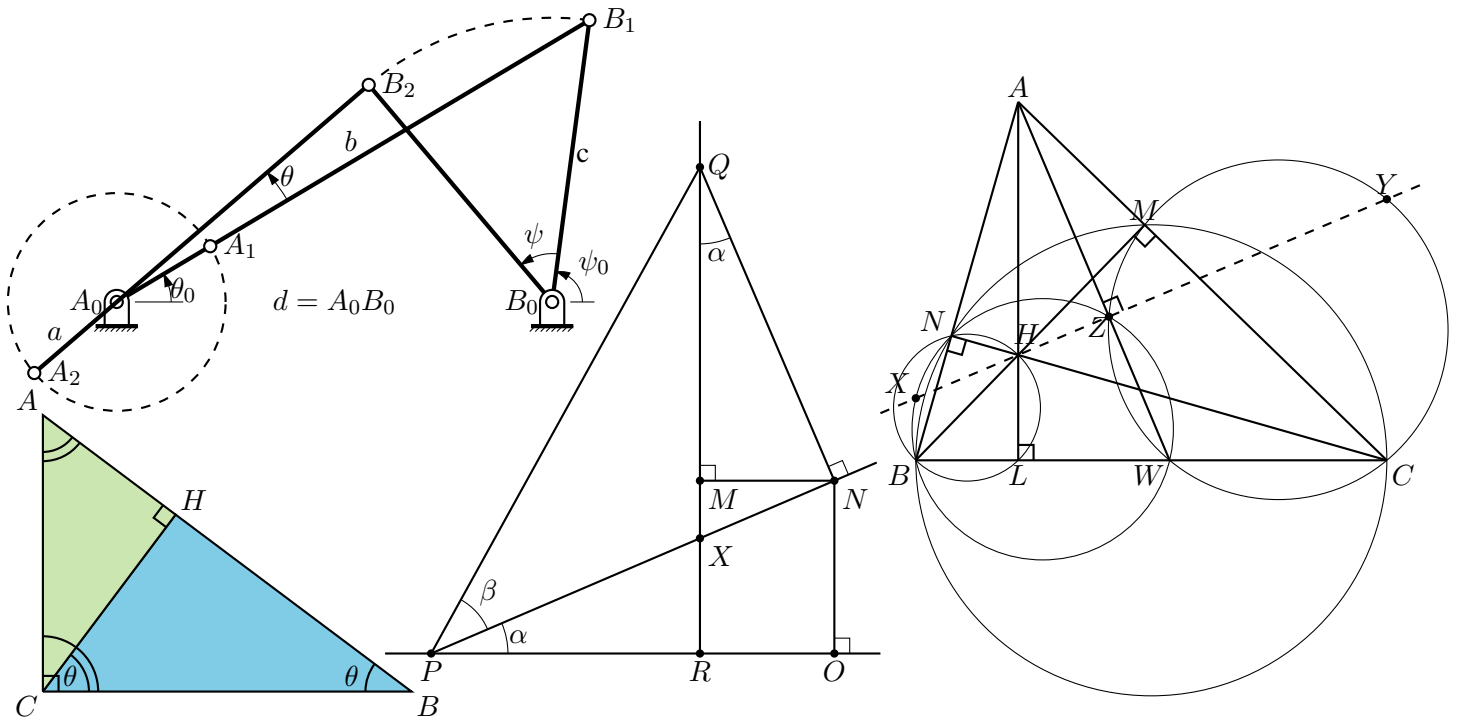


Figure 94: Some geometrical constructions [Geometry.m4].

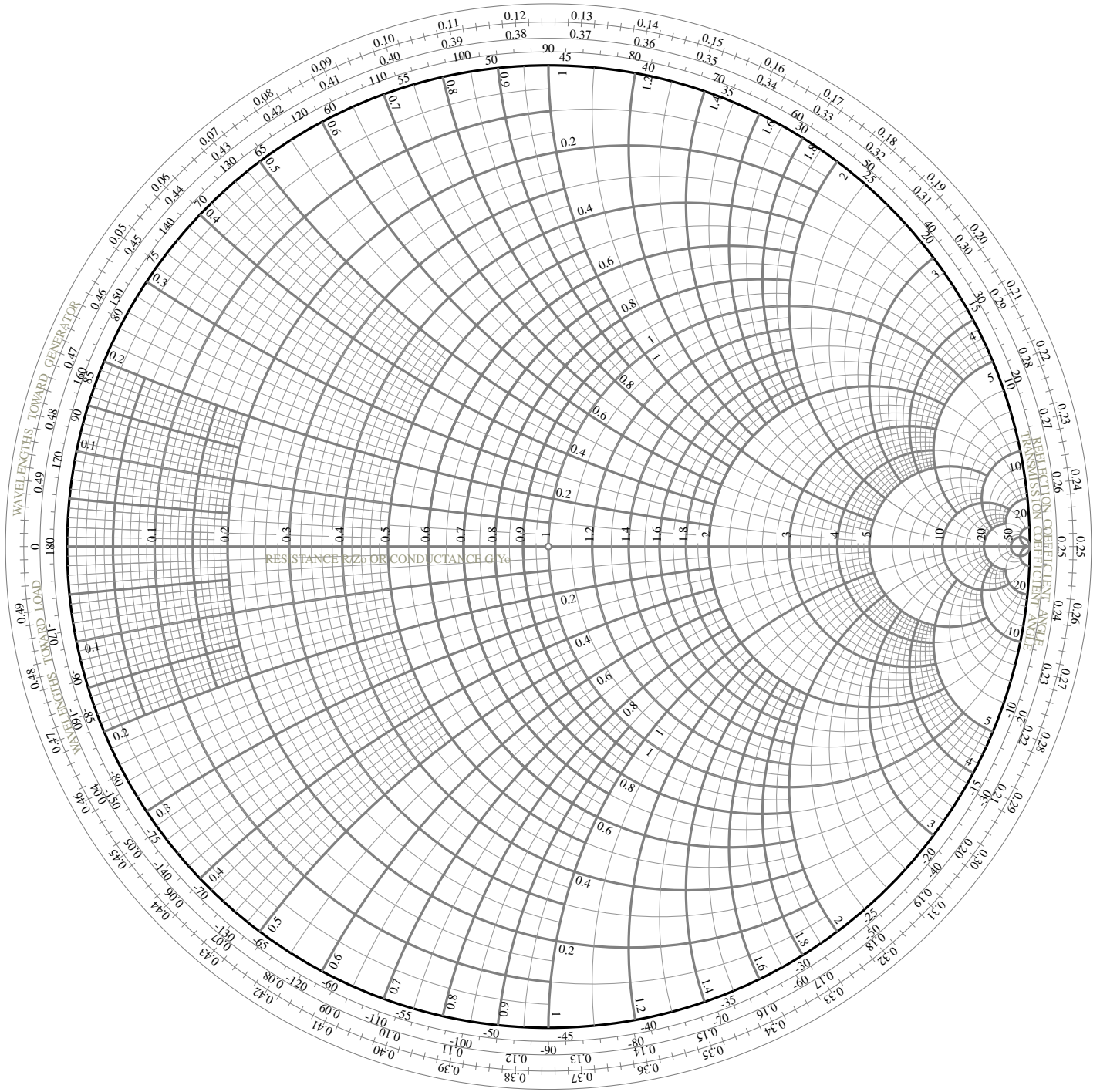
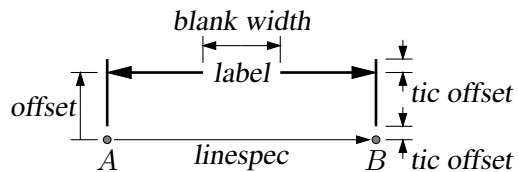
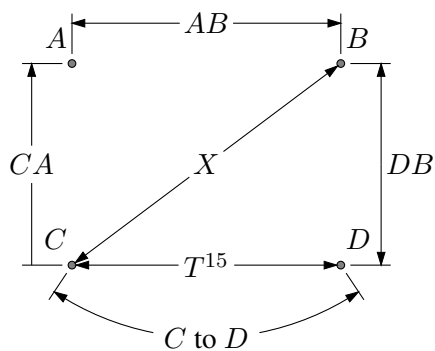
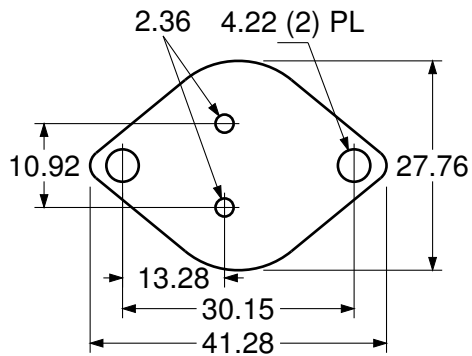


Figure 95: A Smith chart [Smith1chart.m4].



```

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 96: 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].

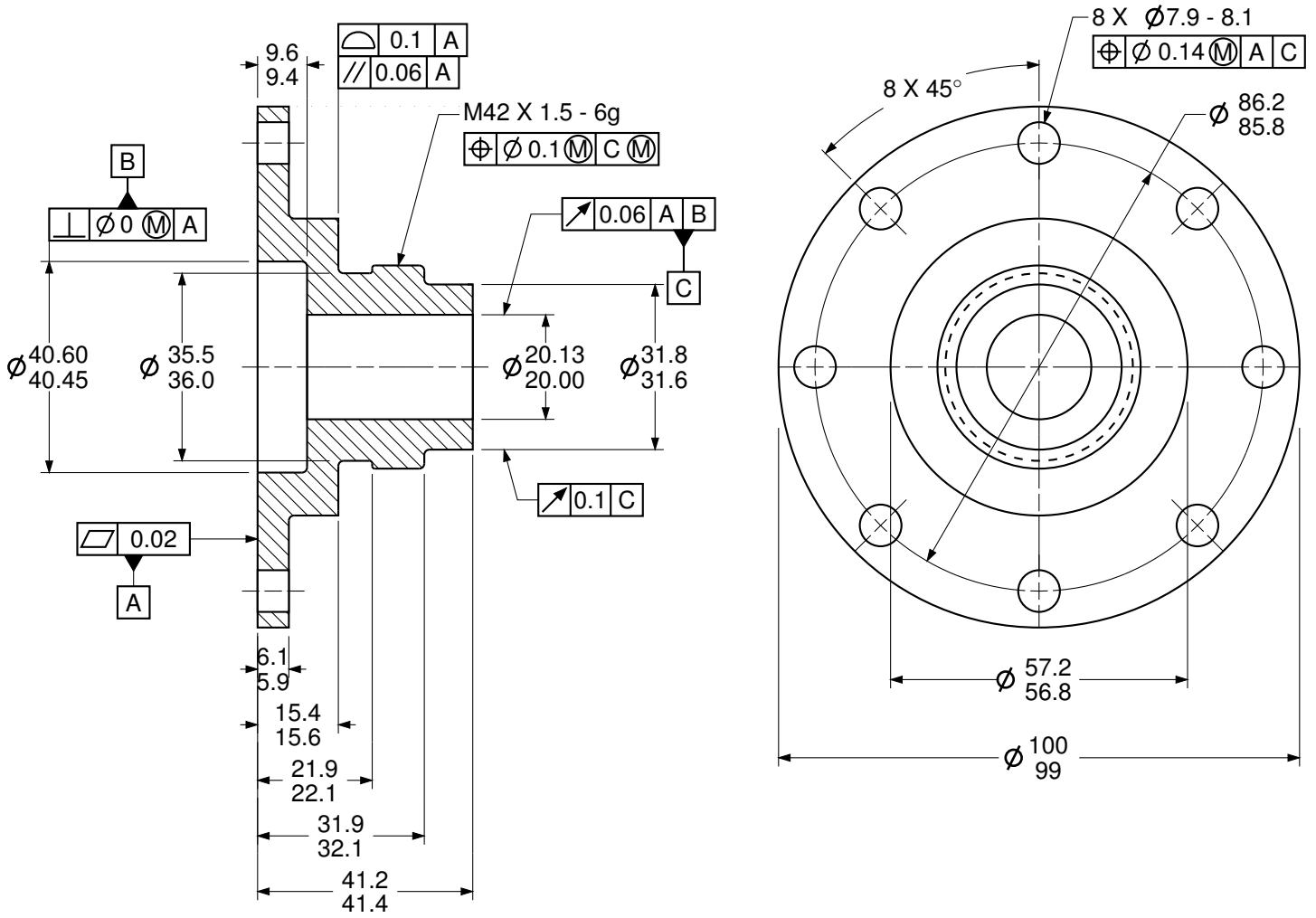


Figure 97: Dimensioning with tolerances [Plate.m4].

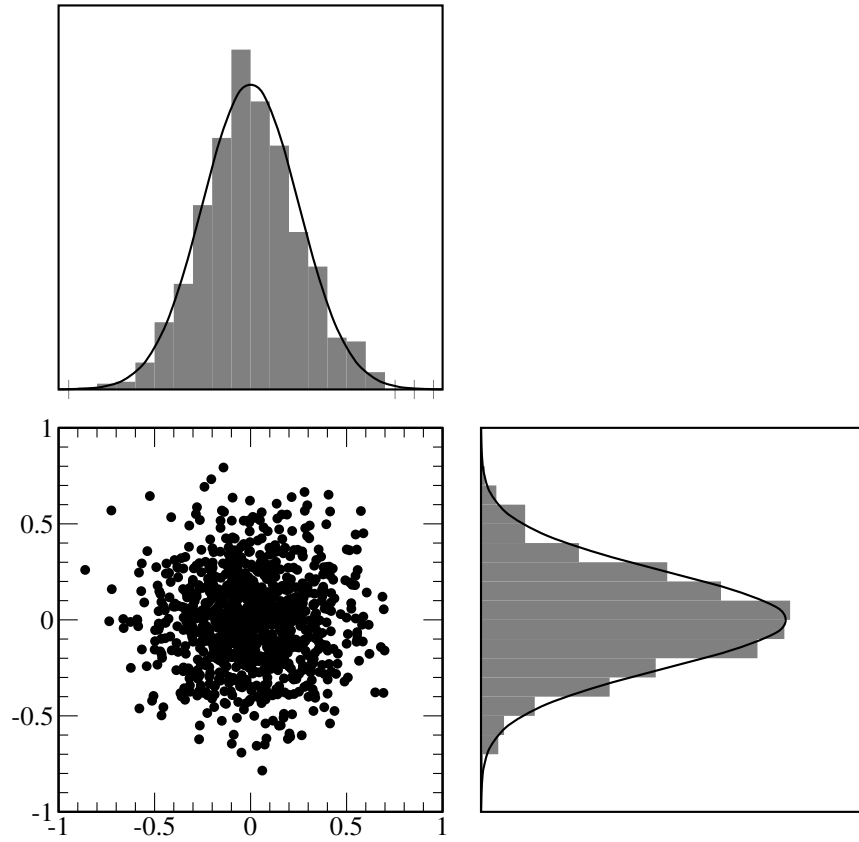


Figure 98: Testing random number generation using `dpic` macro `randn (array name, n, mean, std dev)` which calls `pic` built-in `rand ()` [`random.m4`].

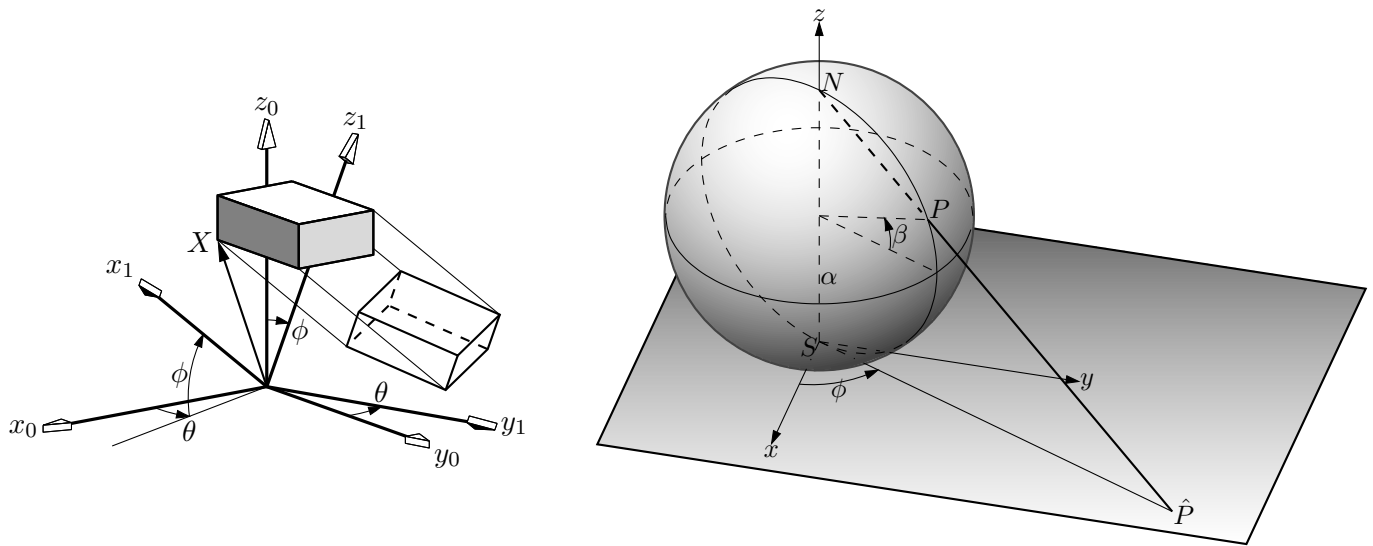


Figure 99: Test of `project` and other `lib3D` macros, showing the projection of a solid onto the y_1, z_1 plane by sighting along the x_1 axis. [`exp.m4`].

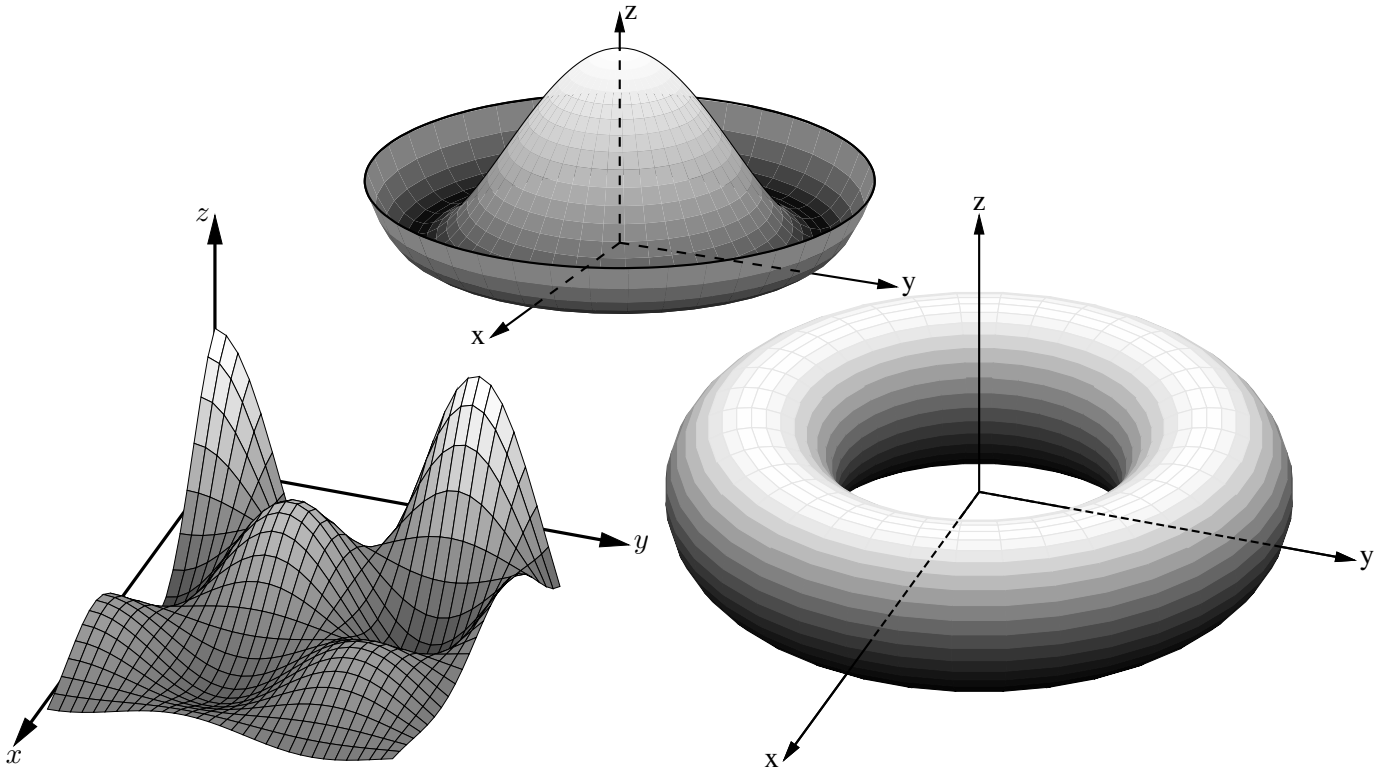


Figure 100: Plotting surfaces using gray scales [graysurf.m4].

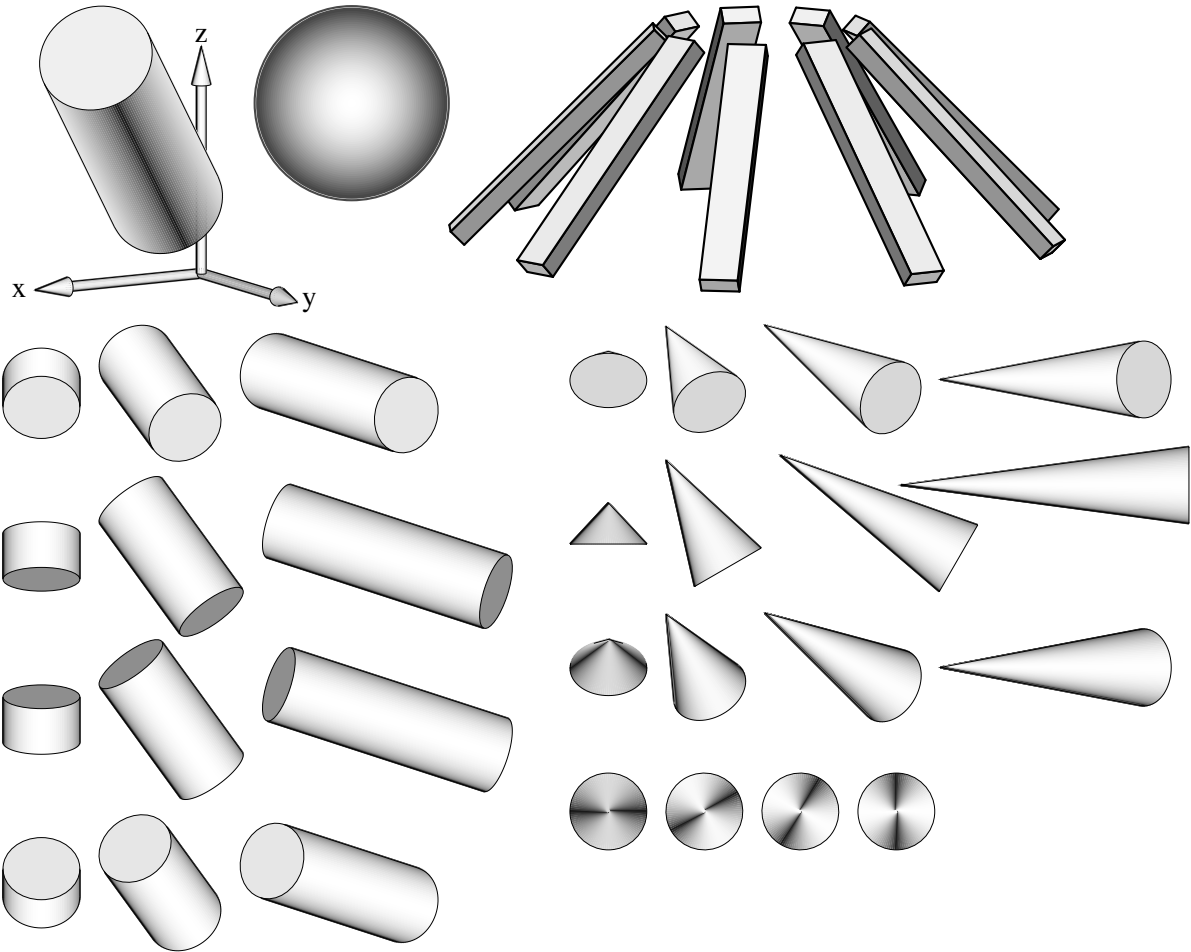


Figure 101: Basic shapes [shapes.m4].

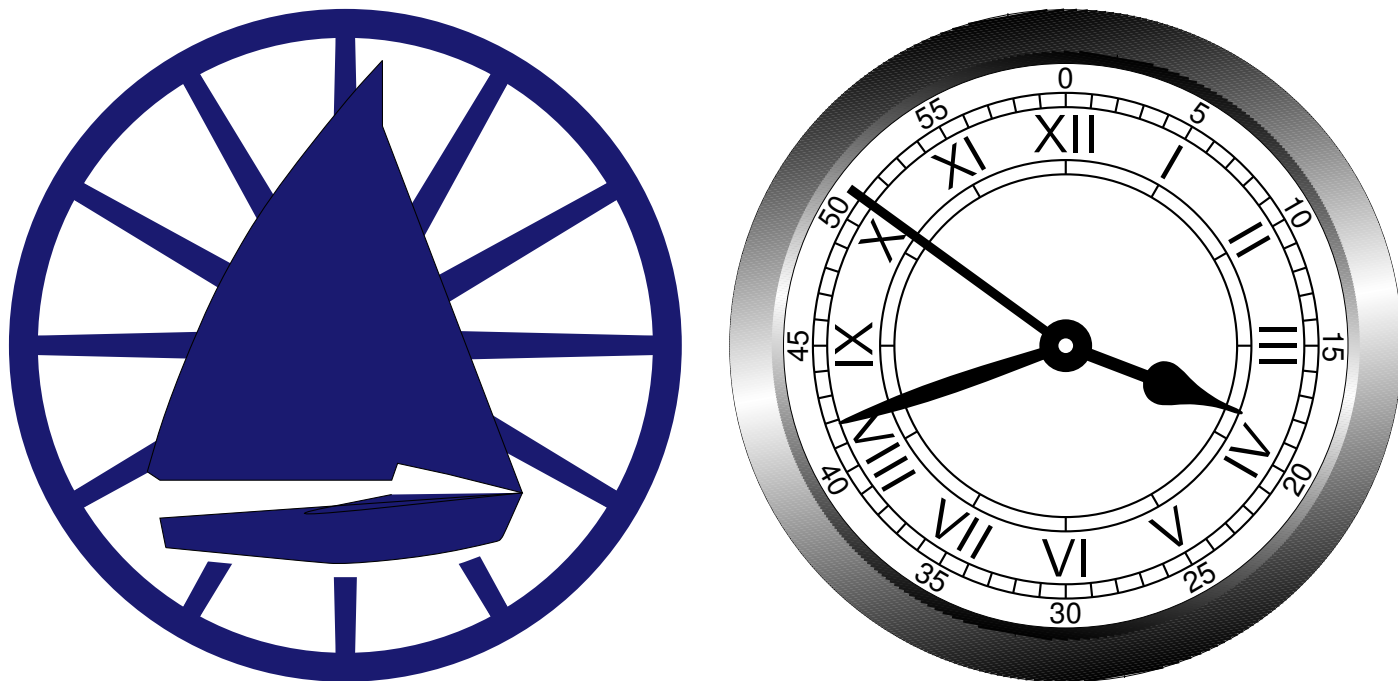


Figure 102: Conestoga Sailing Club (illustrating the filling of arbitrary shapes) and an antique clock face with shading and rotated text [csc.m4].

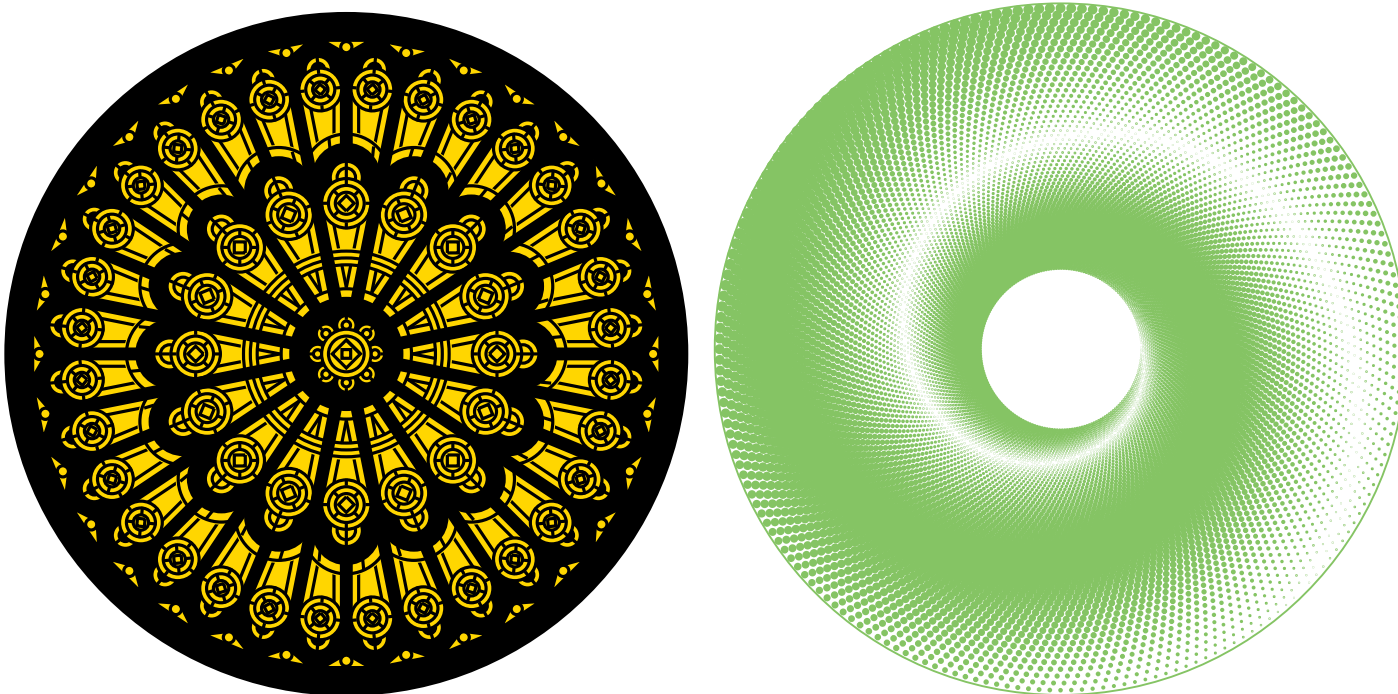


Figure 103: The left object, used for testing `dpic`, is redrawn from a detail of the set design for the musical *Dracula*. This consumes much \LaTeX main memory but can be produced directly as pdf using `dpic -d`, as svg using `dpic -v`, or as postscript using `dpic -r` since no text formatting is required. The right object adjusts the size of dots to produce a halftone effect [rose.m4].

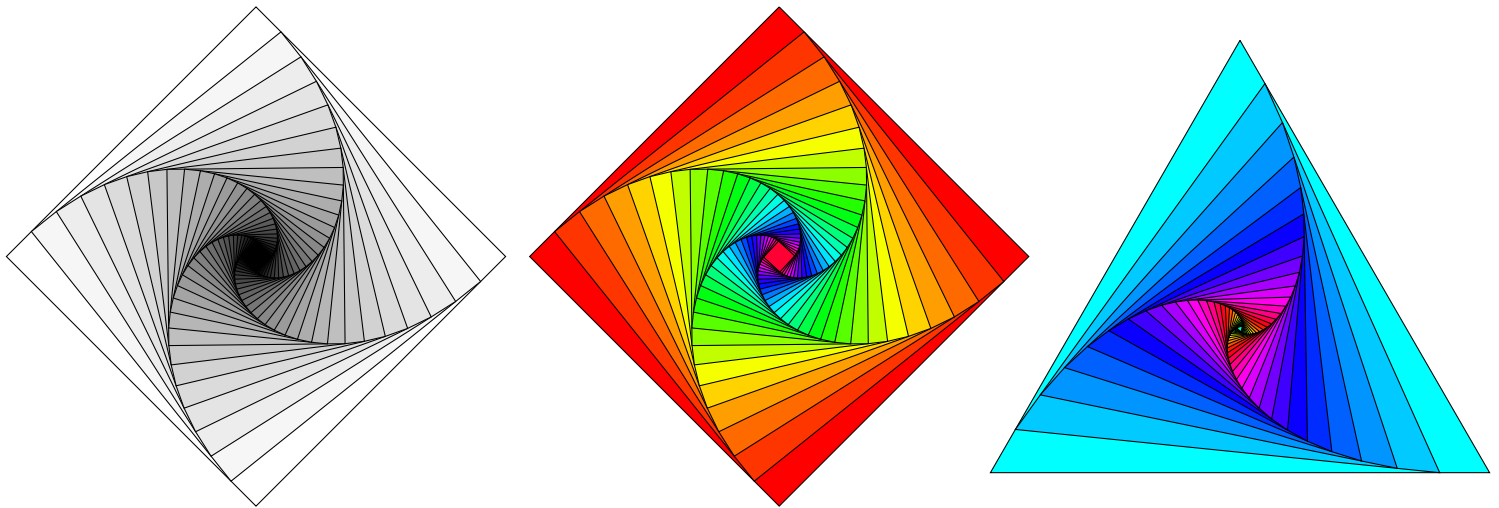


Figure 104: Variations on M. Goossens, S. Rahtz, and F. Mittelbach, *The L^AT_EX Graphics Companion*, Addison-Wesley 1997, pp. 57-58 [diamond.m4].

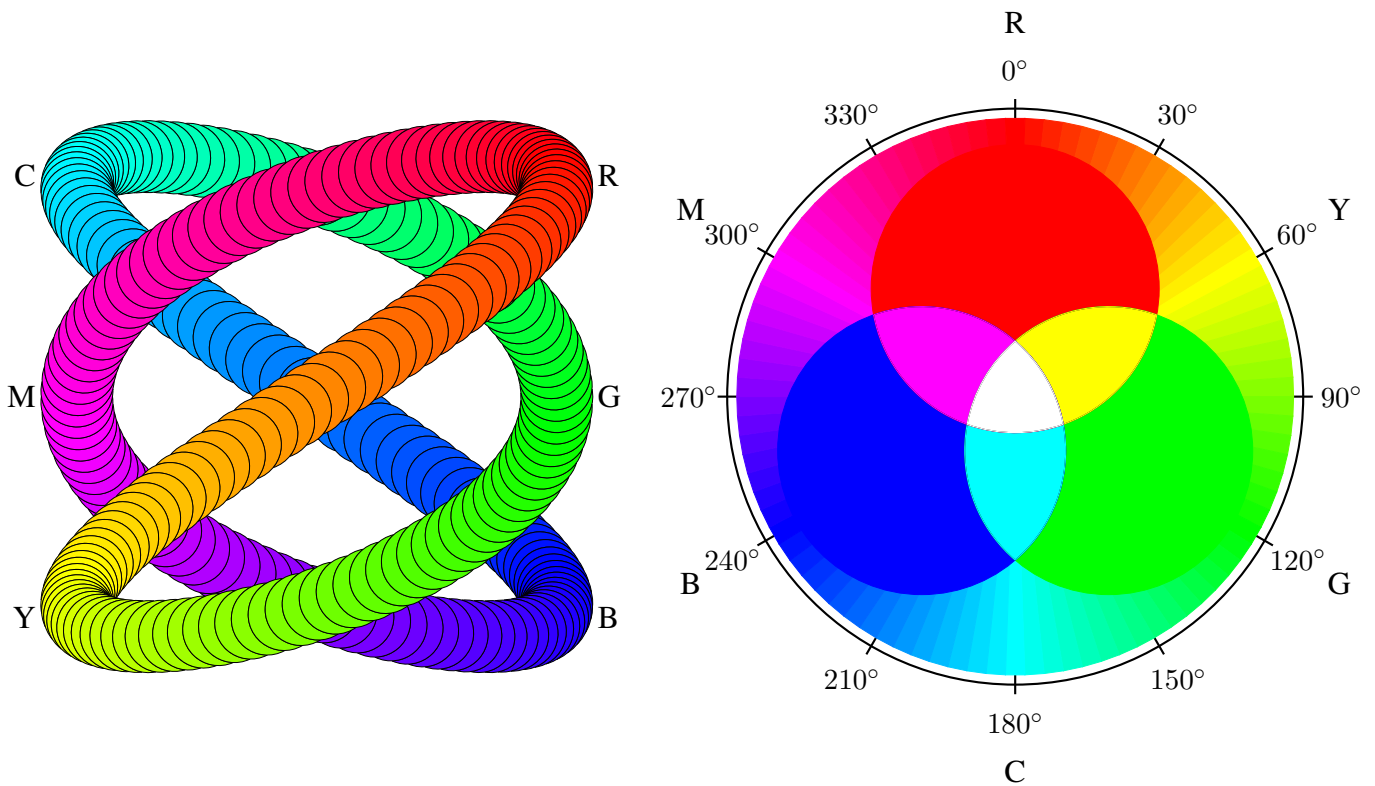


Figure 105: An exercise in calculating RGB colours [worm.m4].

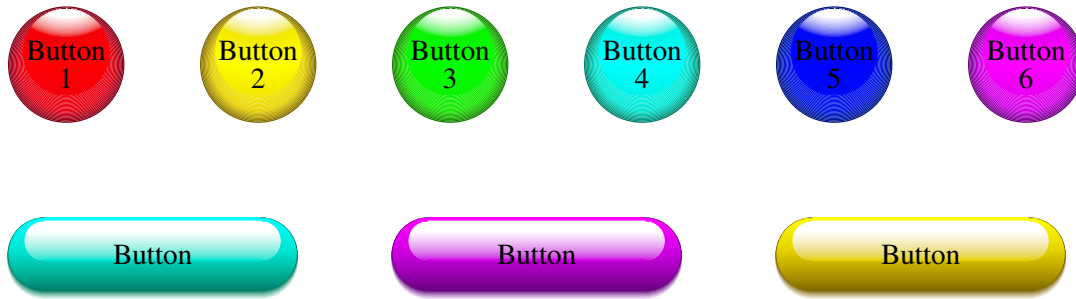


Figure 106: Shading in color [Buttons.m4].

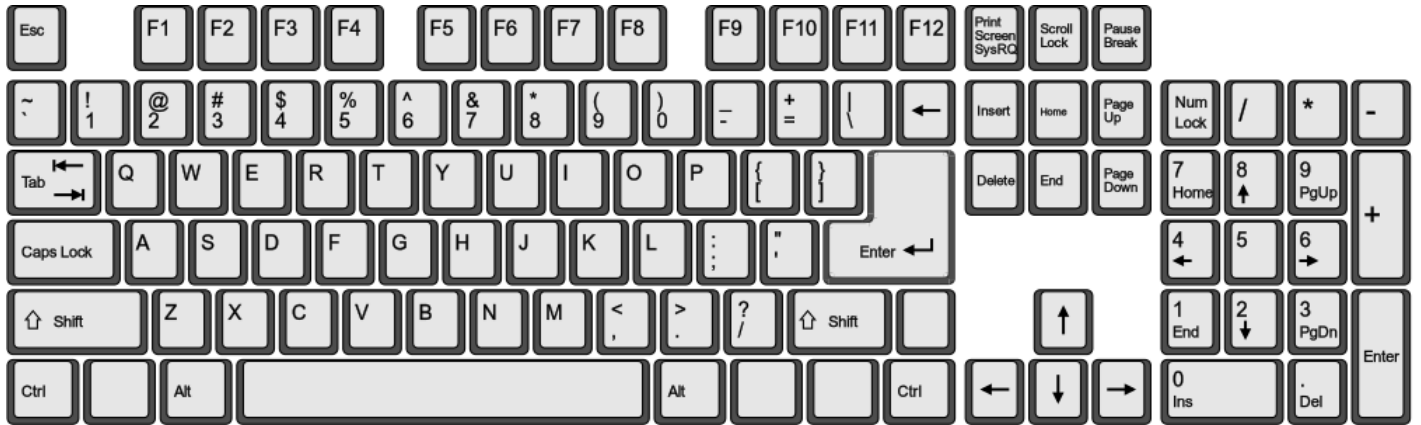


Figure 107: This diagram has been produced as svg with dpc -v (then converted to pdf for inclusion in examples.pdf) [keyboard.m4].

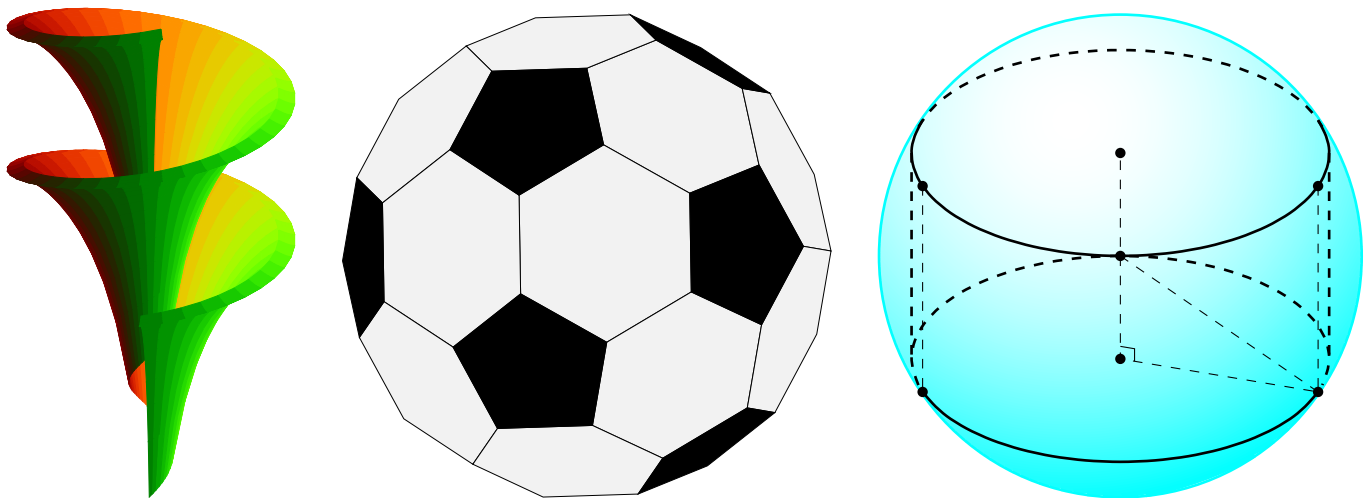


Figure 108: Dini surface, an icosahedron, and a sphere with inscribed cylinder [Dini.m4].

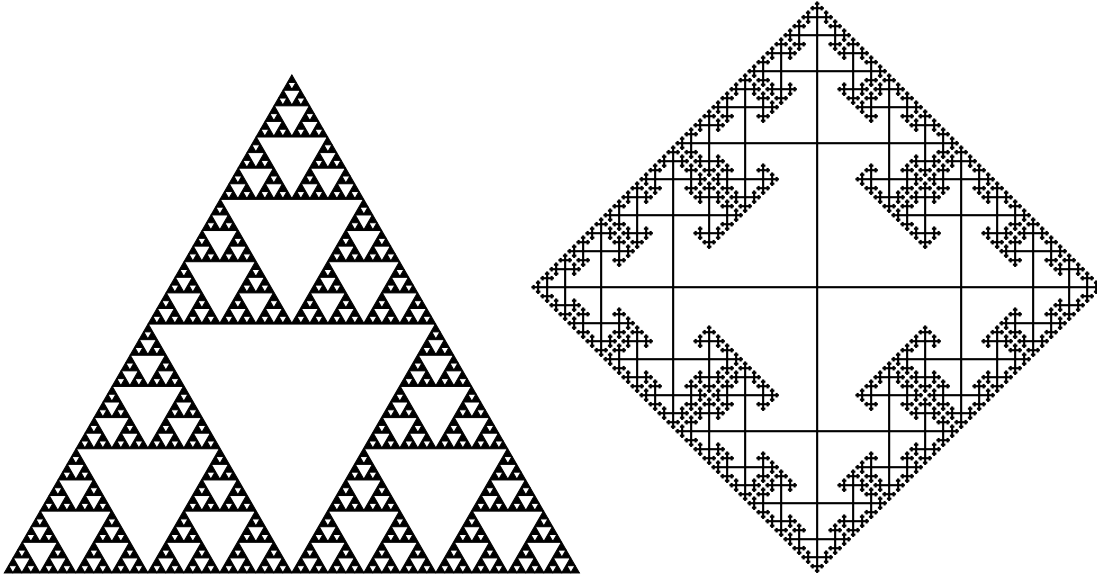


Figure 109: The Sierpinski triangle and a Cayley graph: tests of pic macro recursion [Sierpinski.m4].

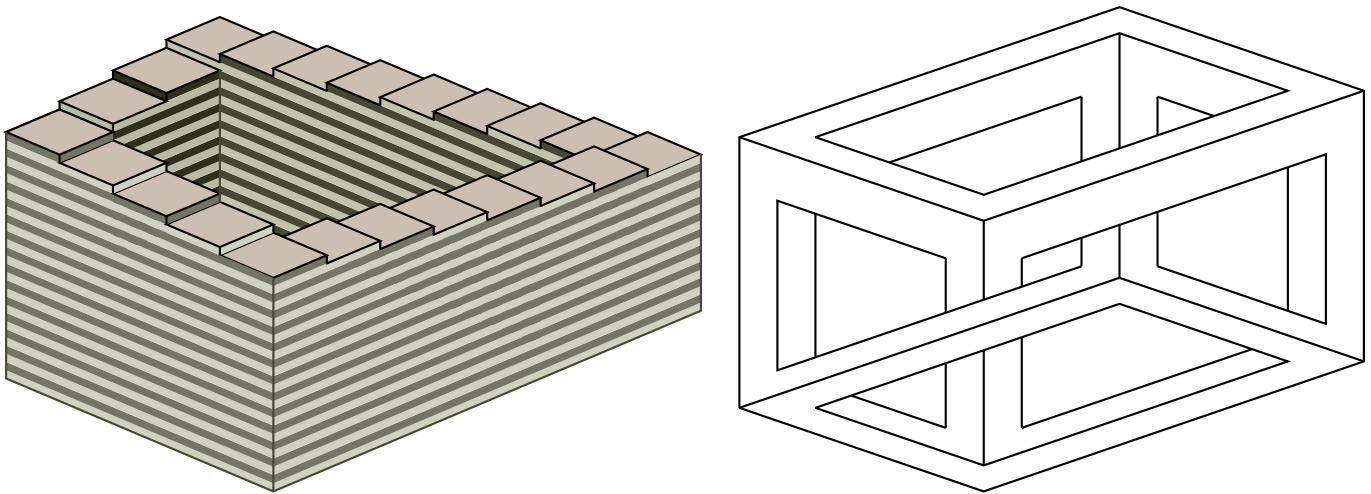


Figure 110: Penrose stairs and an Escher-like object [Escher.m4].

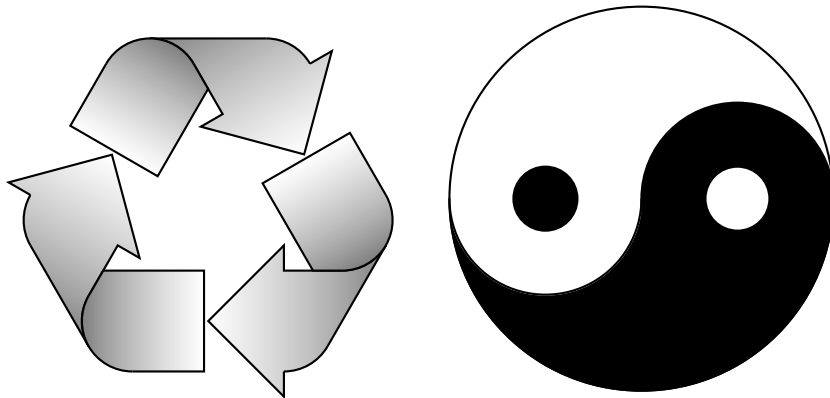


Figure 111: Modest repetition and partial fill [recycle.m4].

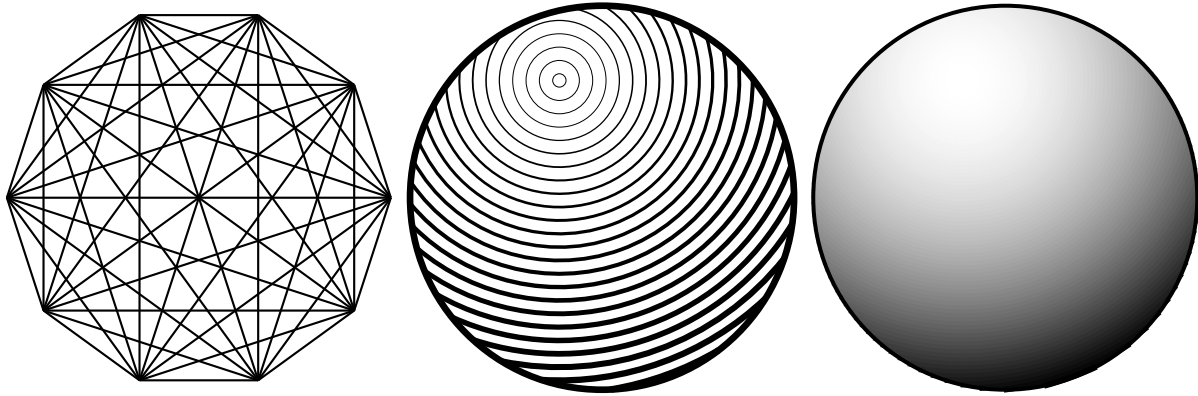


Figure 112: Simple diagrams that are easily drawn by looping [ex15.m4].

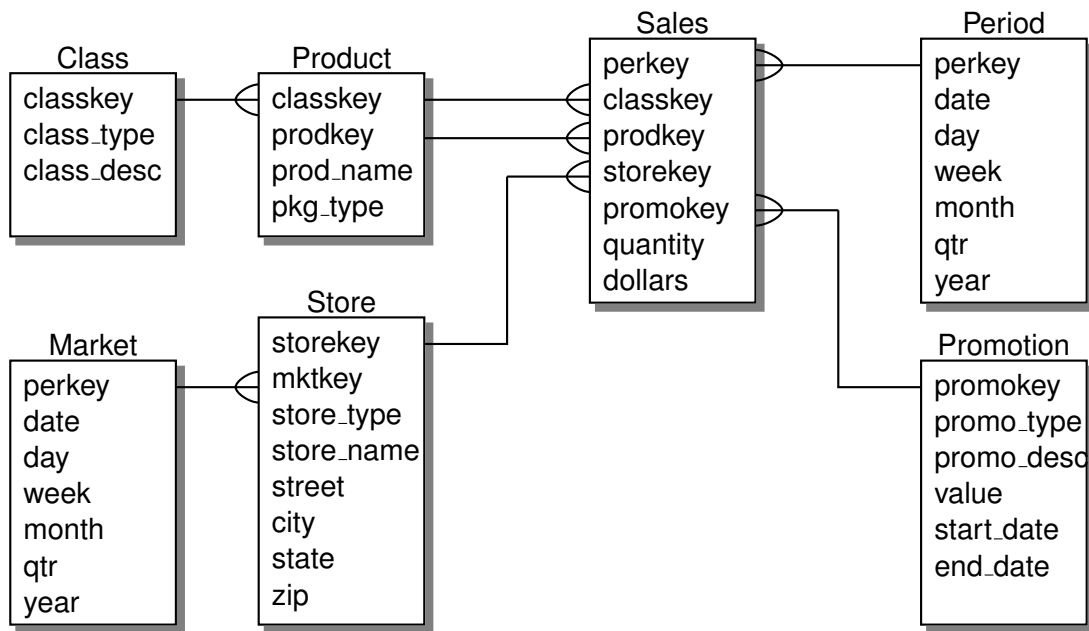


Figure 113: Illustrating shadebox and a custom crowfoot line termination [Crow.m4].

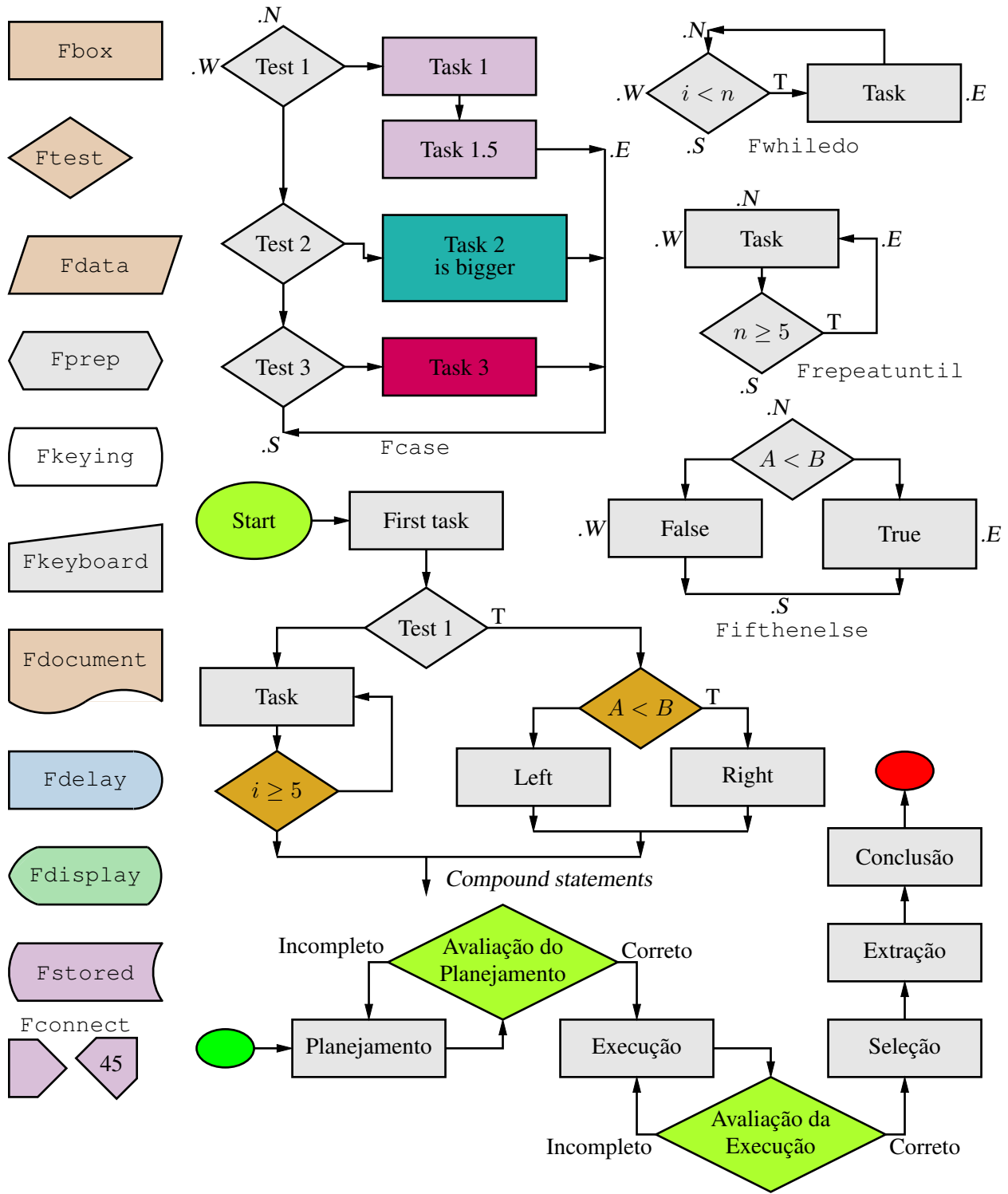


Figure 114: A flowchart sampler [Flow.m4].

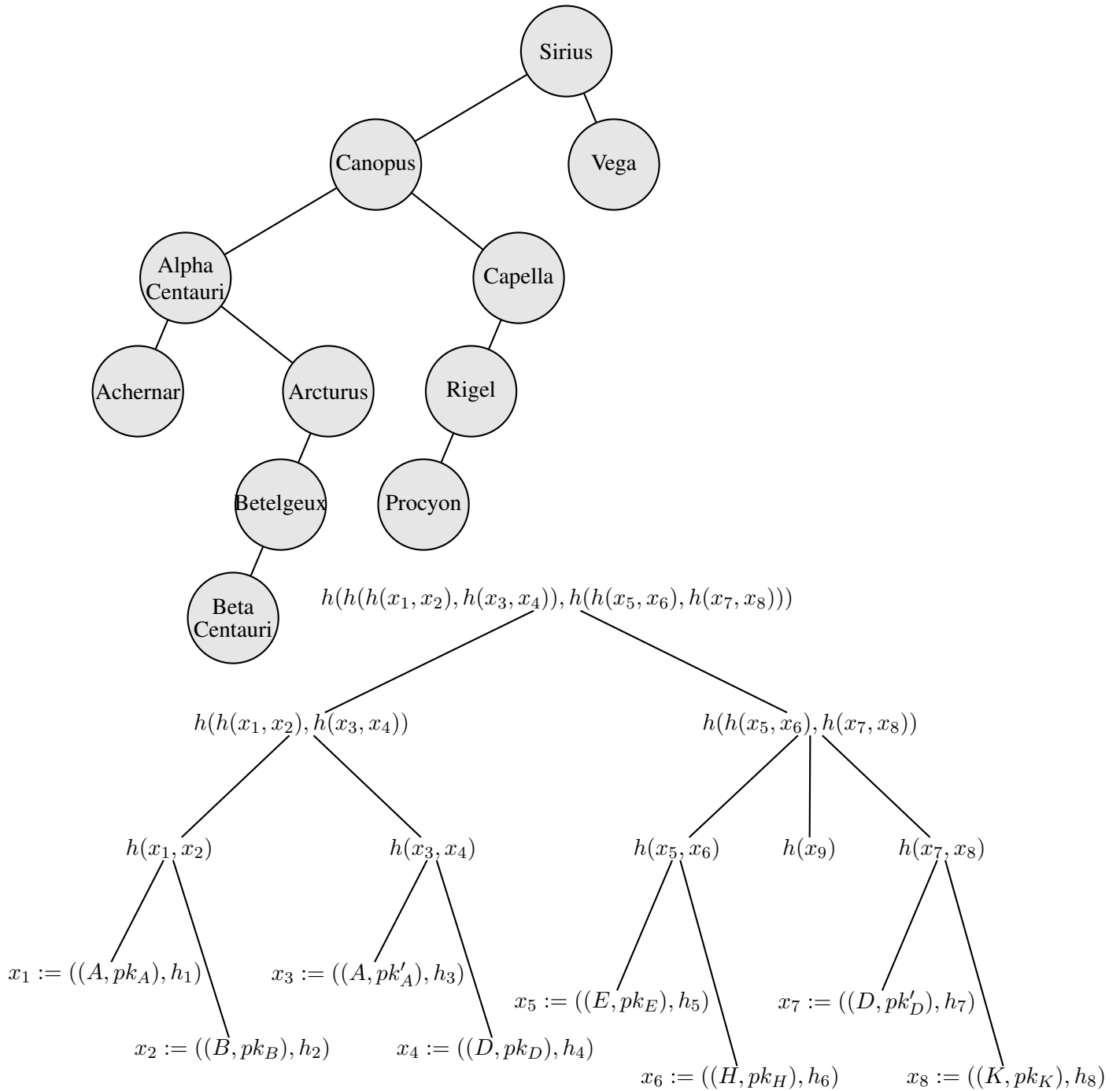


Figure 115: Trees [Btree.m4].



Figure 116: Overlaying a figure with line graphics [Incleps.m4].