

## Examples: Version 10.9.3

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”.

When viewing the results on-screen, be aware that there can be subtle differences in appearance with different viewers, particularly in the weight of thin lines.

Type “make” in the extras directory to see more.

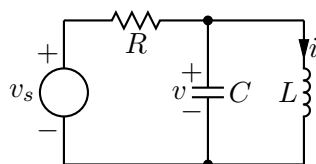


Figure 1: The quick-start example from the manual [quick.m4].

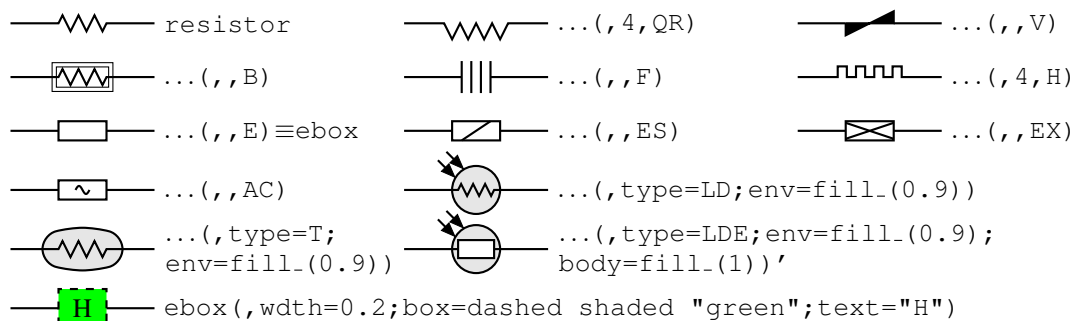


Figure 2: Resistors, showing some variations and the ebox [Resistors.m4].

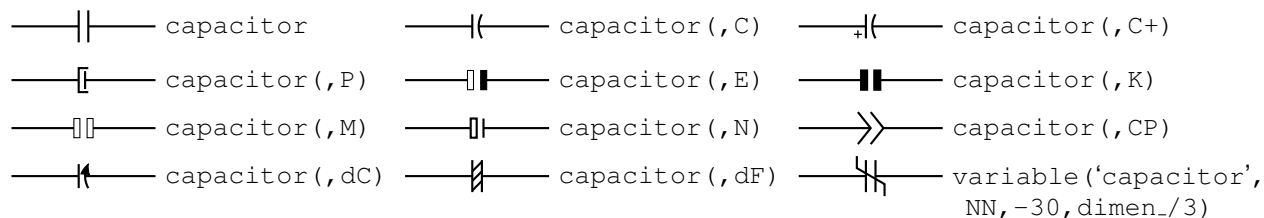


Figure 3: Capacitors [Capacitors.m4].

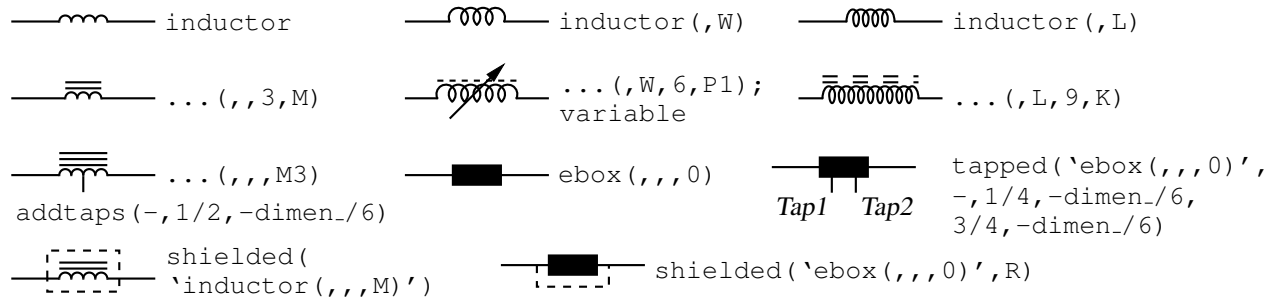


Figure 4: Inductors [Inductors.m4].

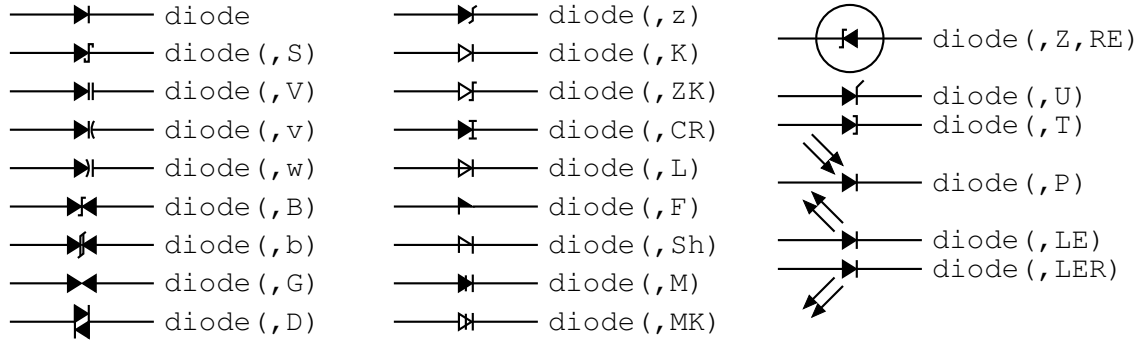


Figure 5: Diodes: appending a K to the second argument draws an open arrowhead [Diodes.m4].

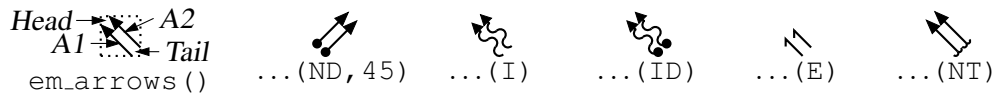


Figure 6: Radiation arrows [Emarrows.m4].

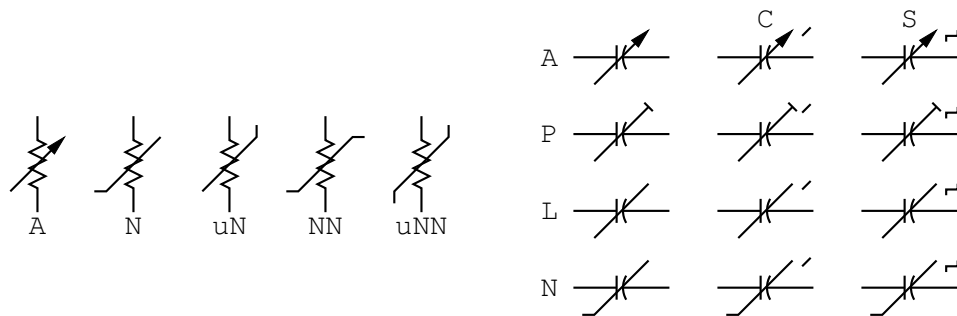


Figure 7: Arrows and marks for showing variability [Variable.m4].

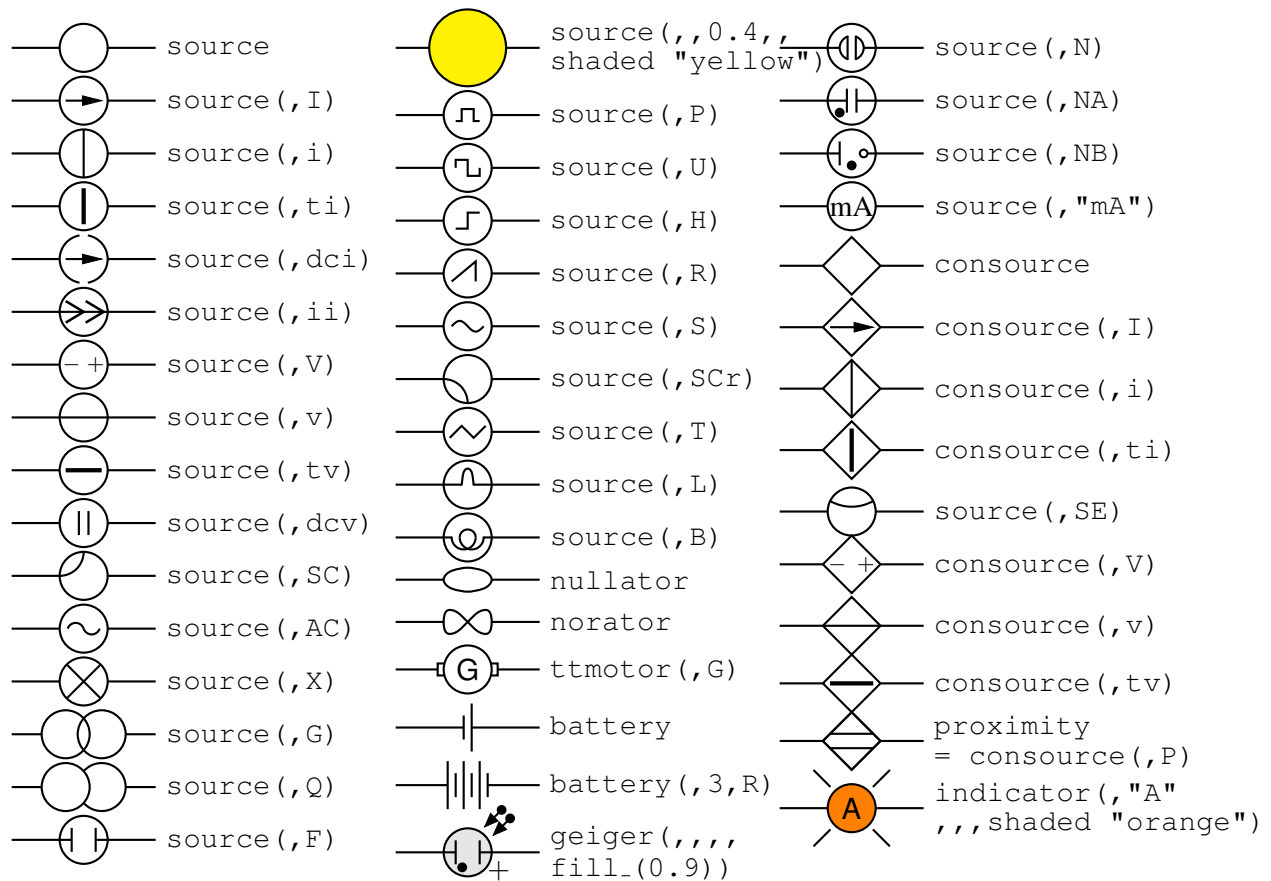


Figure 8: Sources and source-like elements [Sources.m4].

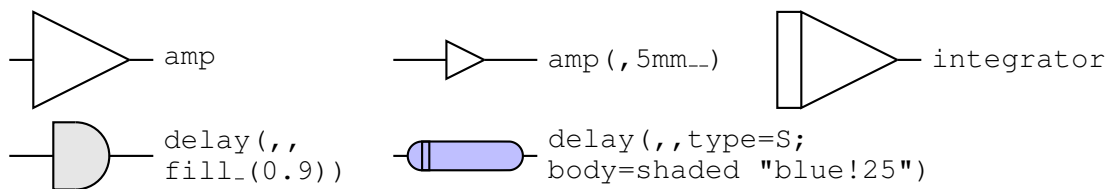


Figure 9: Macros amp, delay, and integrator [AmpTable.m4].

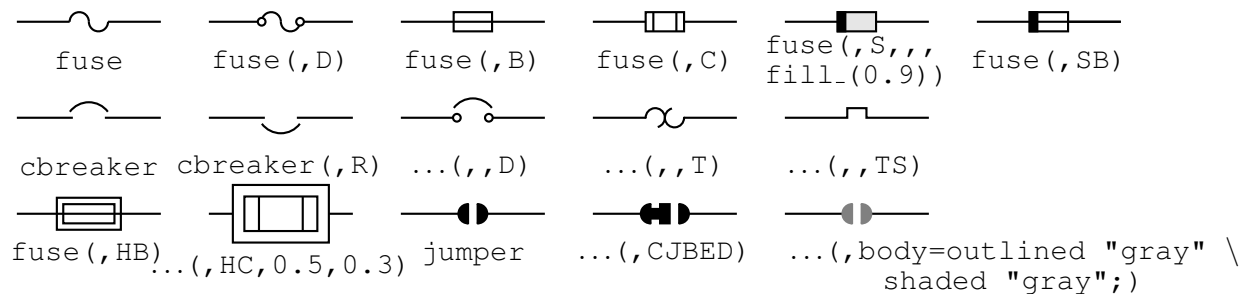


Figure 10: Macros fuse, cbreaker, and jumper [Fuses.m4].

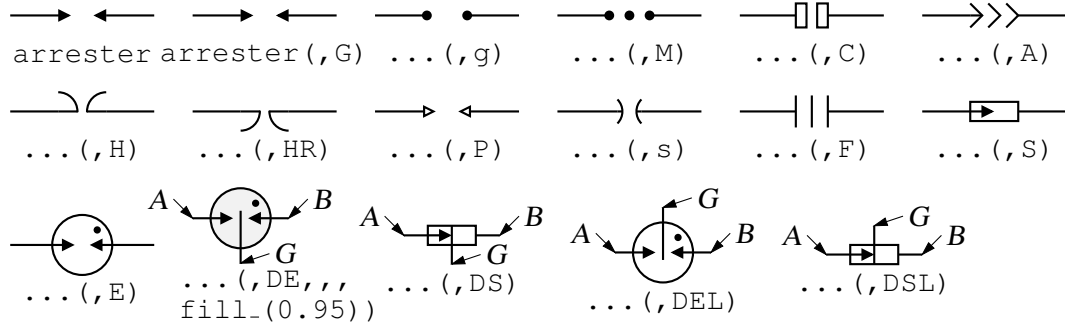


Figure 11: The arrester macro [Arresters.m4].

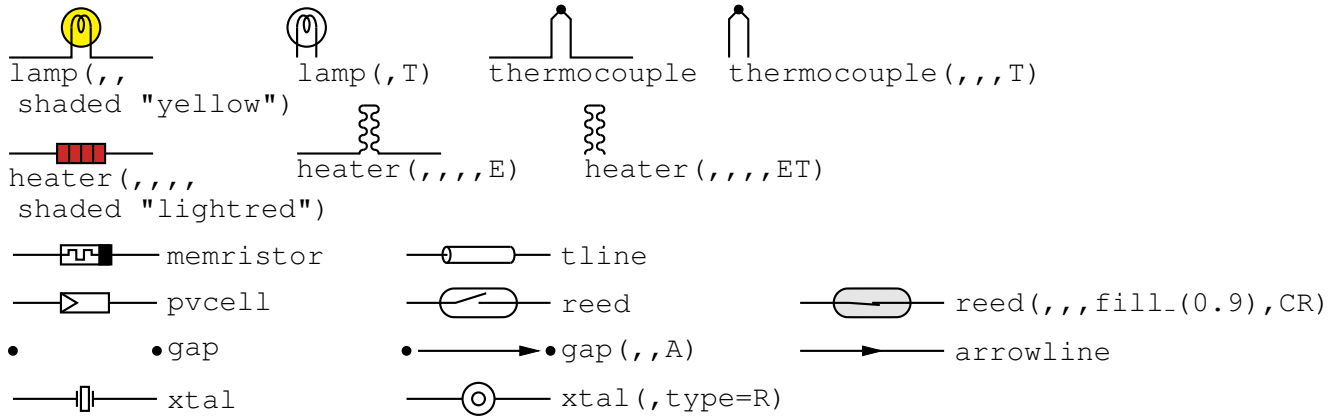


Figure 12: Additional two-terminal elements [MoreTable.m4].

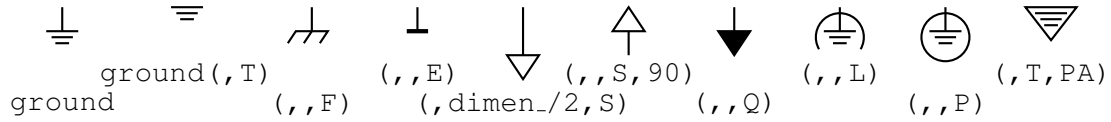


Figure 13: Ground symbols [Grounds.m4].

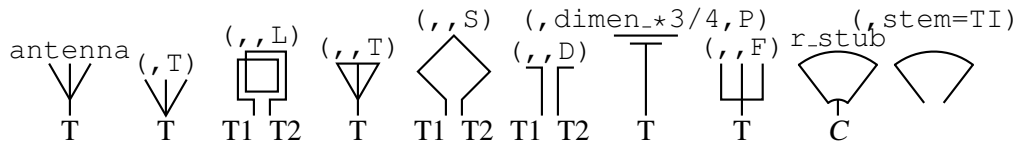


Figure 14: Antenna symbols and the microstrip radial stub [Antennas.m4].

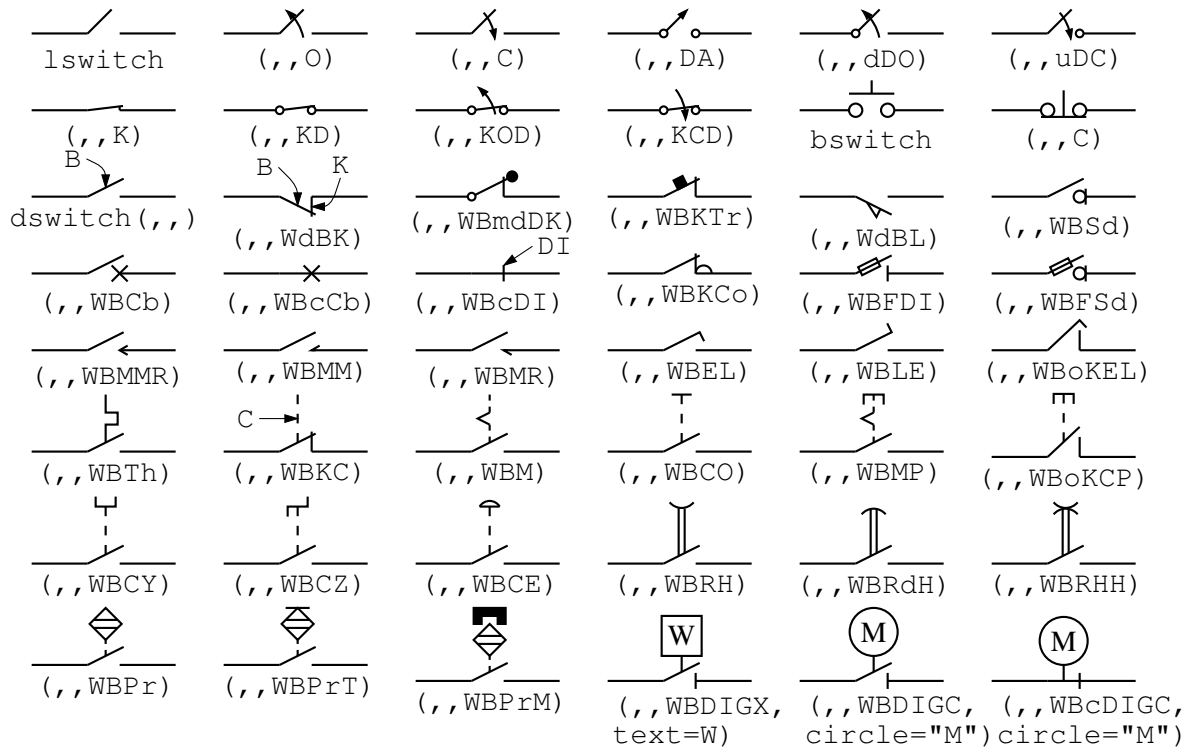


Figure 15: The switch macros; `switch(,,L|B|D)` is a wrapper for `lswitch`, `bswitch`, and `dswitch` [Switches.m4].

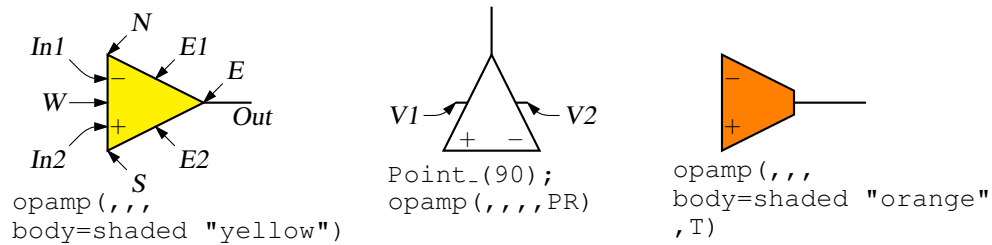


Figure 16: The opamp [Opamp.m4].

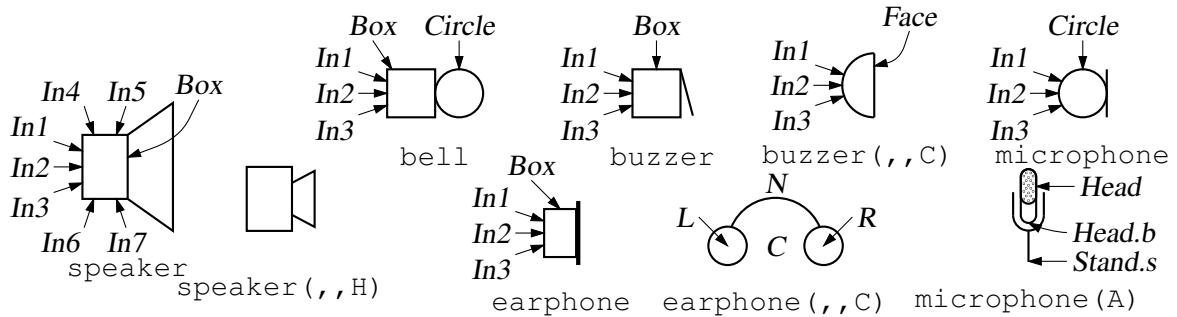


Figure 17: Audio elements [Audio.m4].

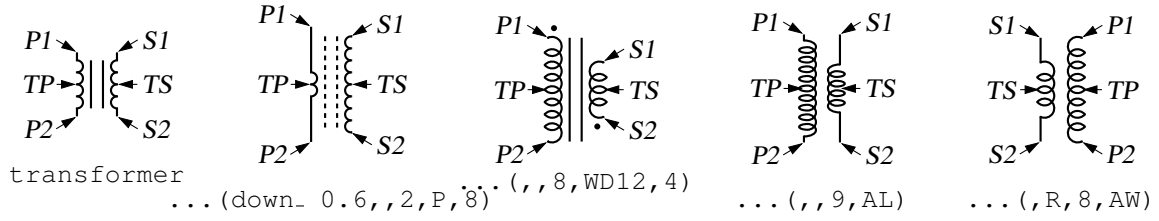


Figure 18: Some variations of the transformer element, drawing direction down [Xform.m4].

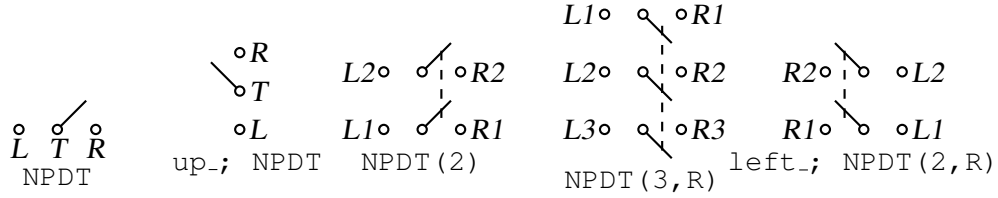


Figure 19: Double throw with the NPDT macro [NPDT.m4].

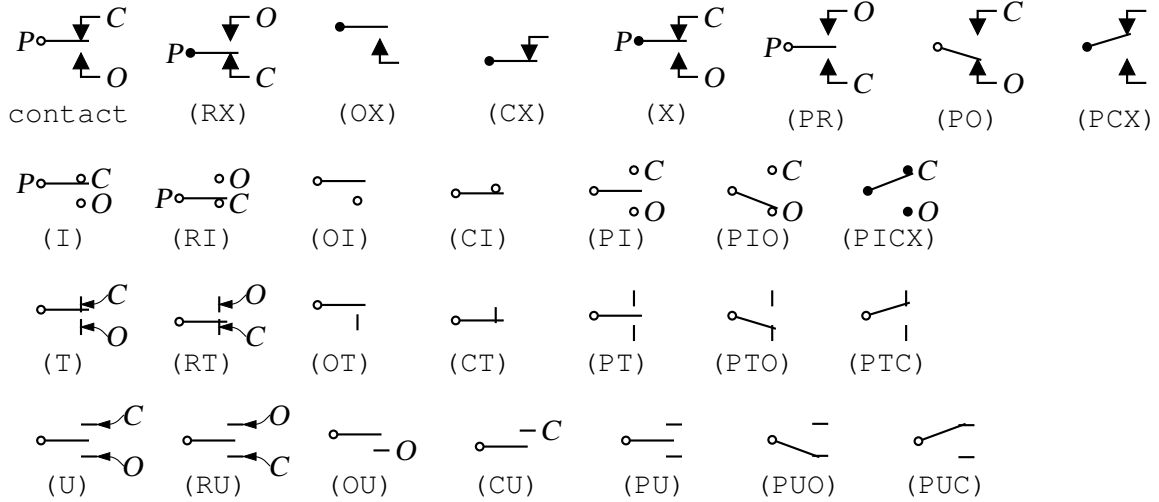


Figure 20: A non-exhaustive sampling of contact macro variations [Contact.m4].

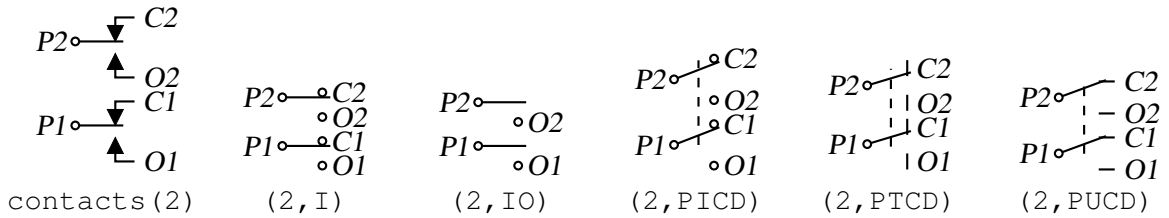


Figure 21: The contacts macro [Contacts.m4].

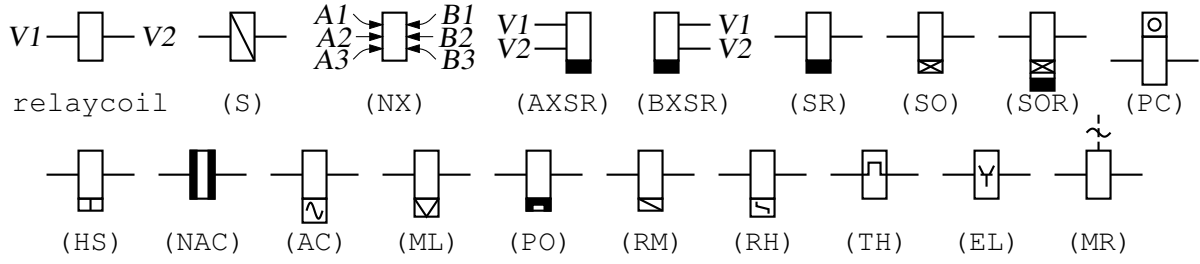


Figure 22: The relaycoil macro [relaycoil.m4].

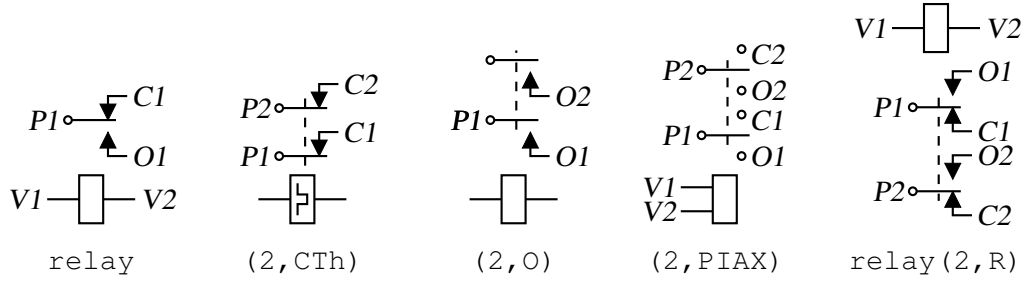


Figure 23: Some variants of relay [Relay.m4].

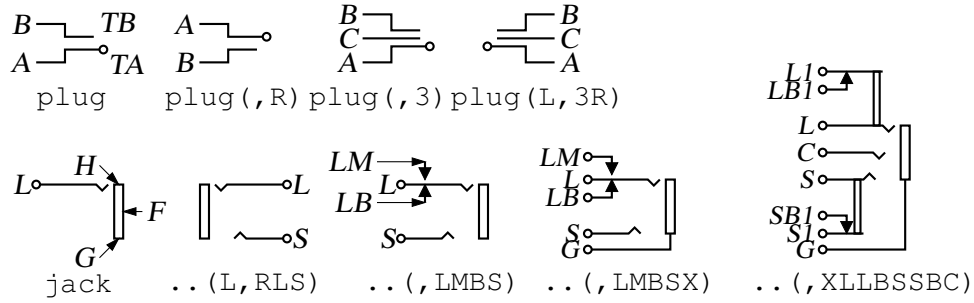


Figure 24: The jack and plug macros [Jack.m4].

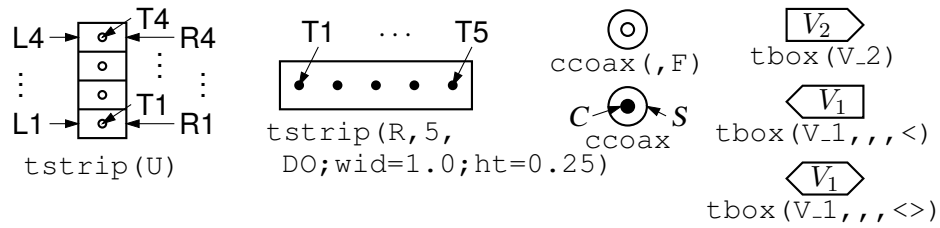


Figure 25: The tstrip, ccoax, and tbox macros [Tstrip.m4].

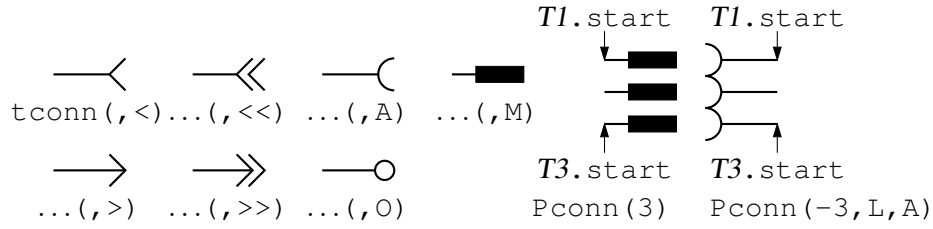


Figure 26: The `tconn` and `Pconn` macros [Conn.m4].

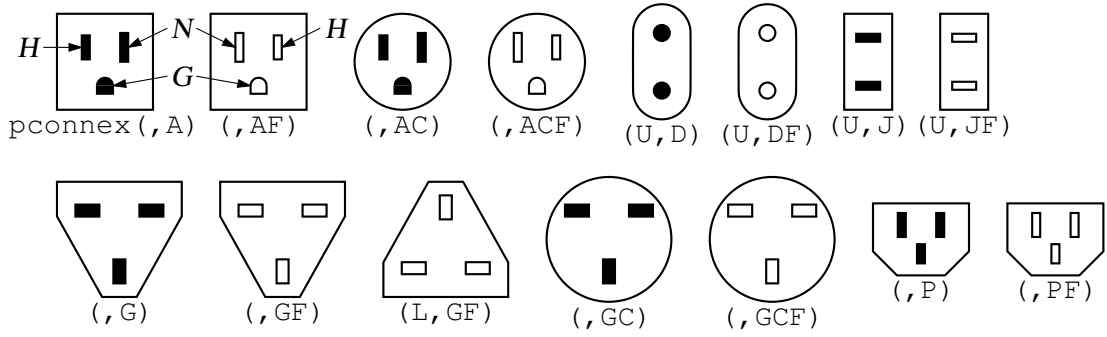


Figure 27: The `pconnex` macro [Pconn.m4].

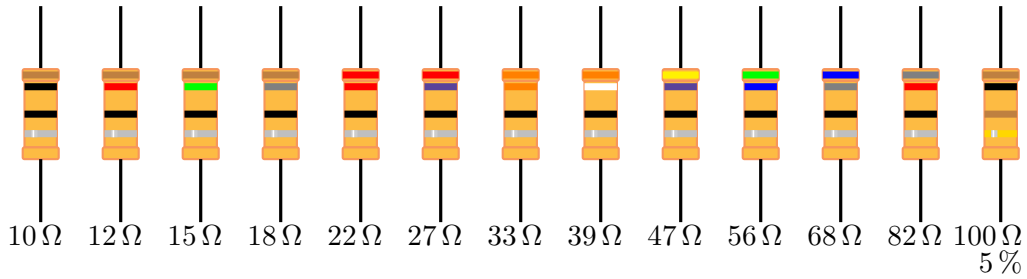


Figure 28: Color-coded through-hole resistors. All are 10 percent tolerance except the last, which illustrates 5 percent [cbresistor.m4].

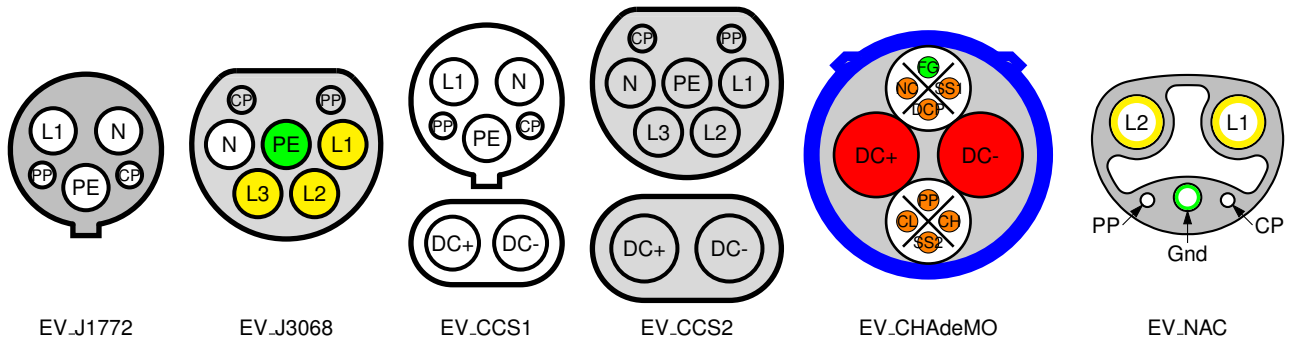


Figure 29: Electric vehicle charging plug patterns make extensive use of `key=value` pairs to set options [EVplugs.m4].



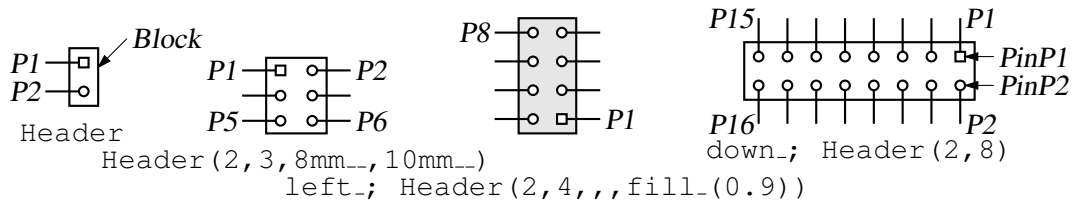


Figure 30: The Header macro [Headers.m4].

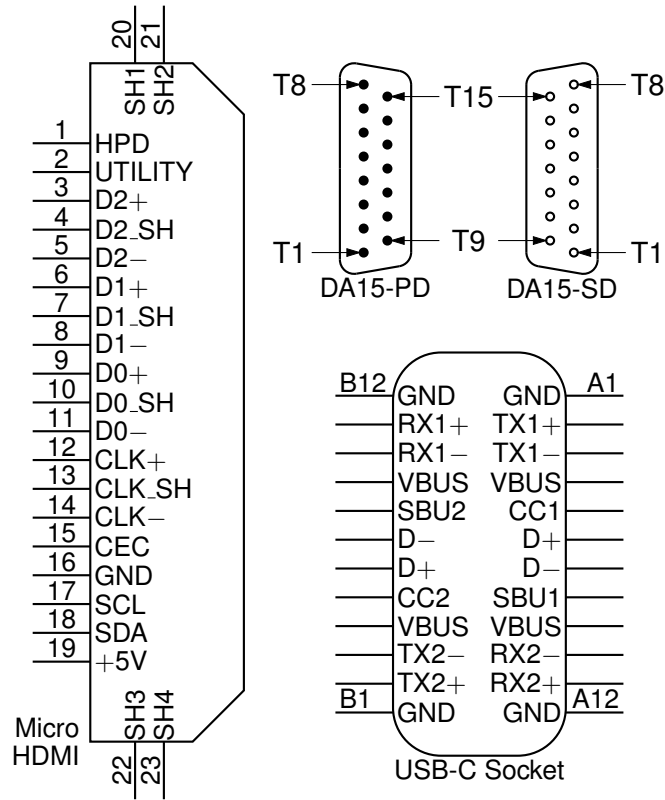


Figure 31: Some connectors with simple geometry and lists of labels [Sockets.m4].

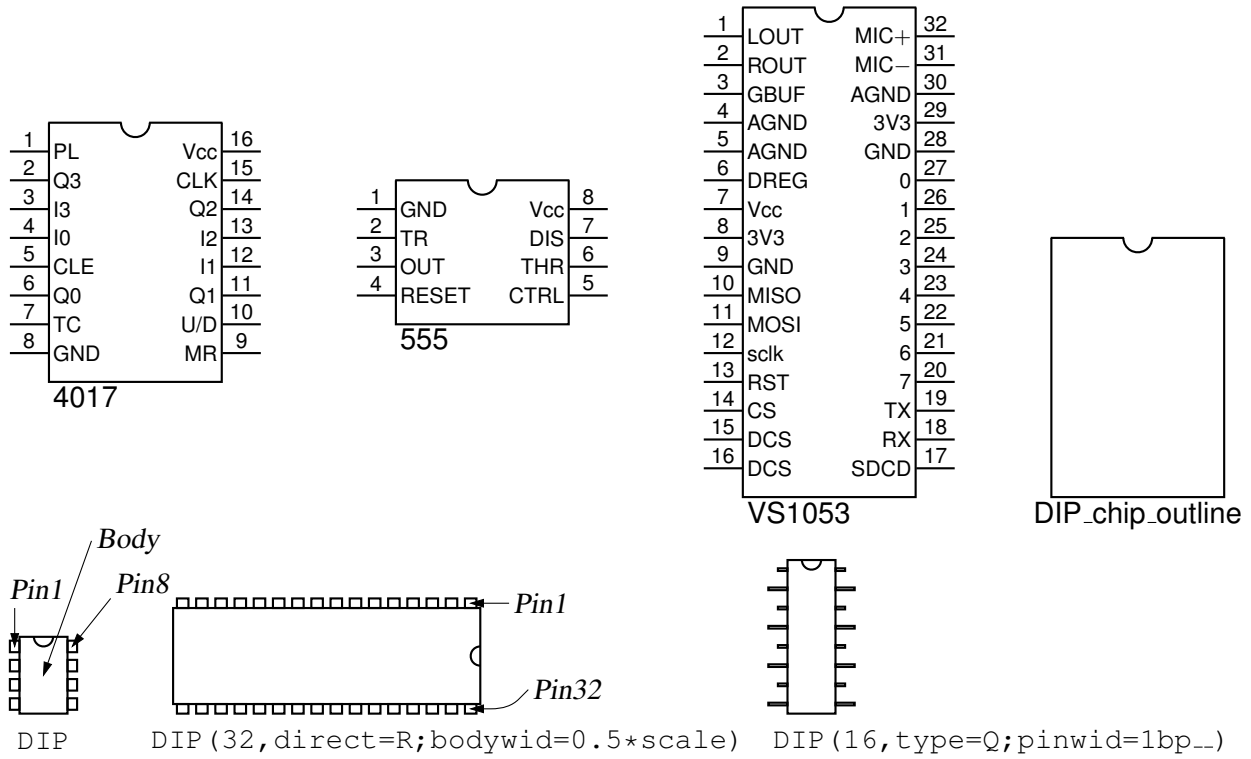


Figure 32: IC package outlines and examples [Chips.m4].

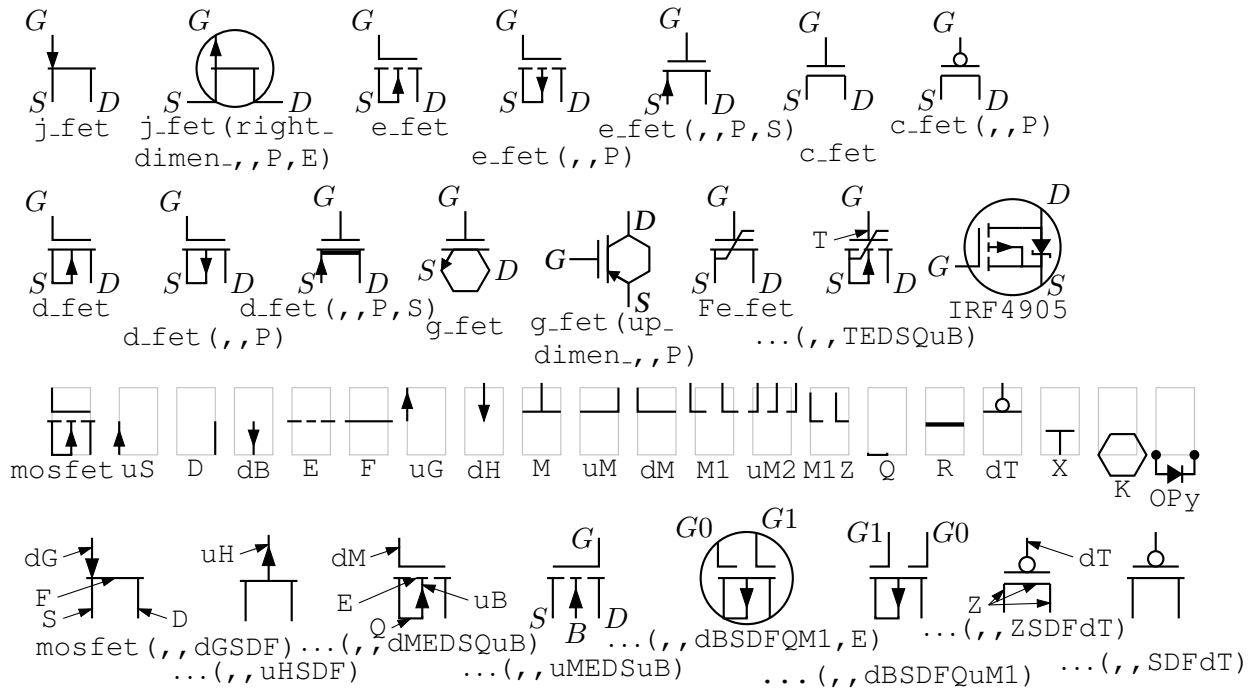


Figure 33: FETs, showing programmable components and example customizations [fet.m4].

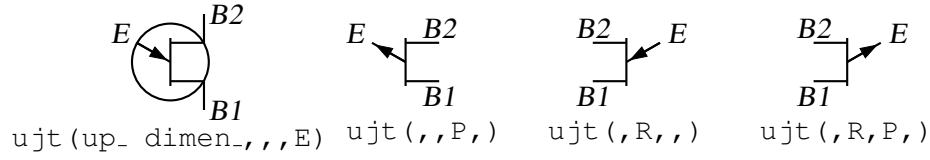


Figure 34: UJT examples [ujt.m4].

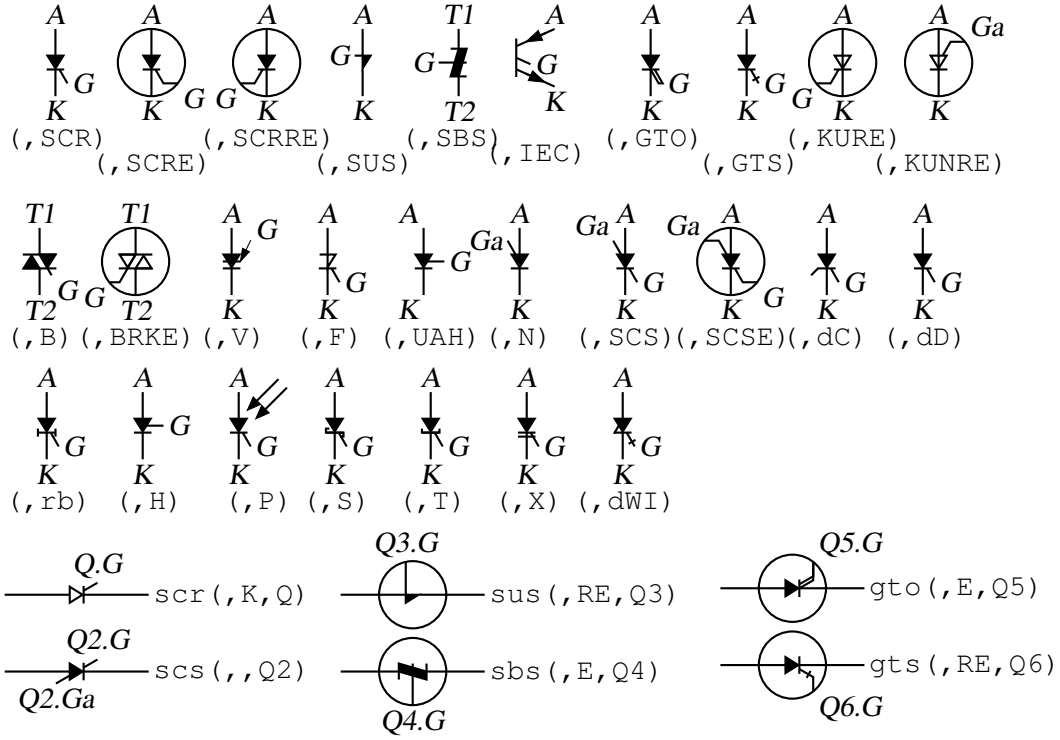


Figure 35: Thyristor examples. The thyristor is a 3- or 4-terminal composite element [Thyristor.m4].

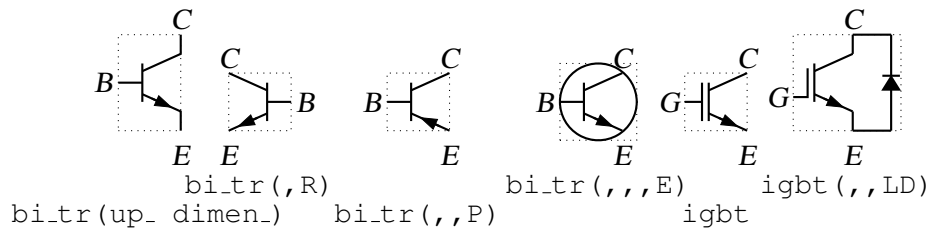


Figure 36: Bipolar transistors (drawing direction: up) [Bip.m4].

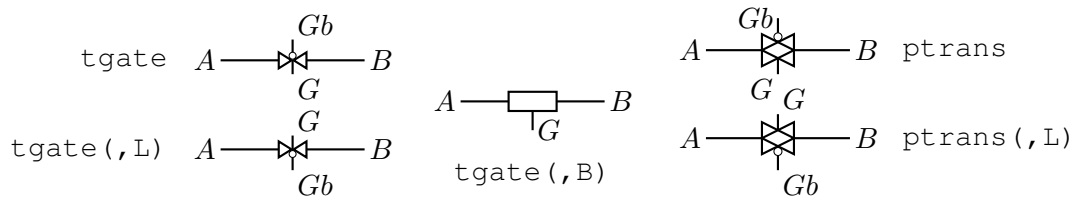


Figure 37: The `tgate` and `ptrans` elements [Tgate.m4].

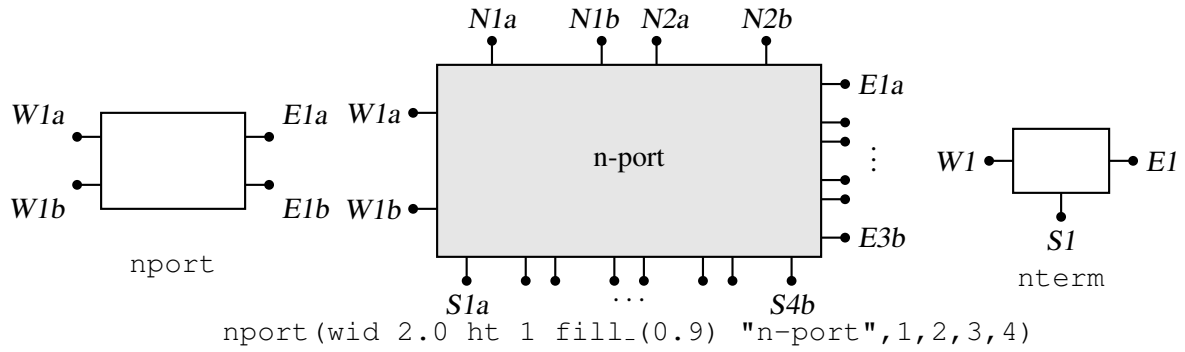


Figure 38: The `nport` and `nterm` macros [Nport.m4].

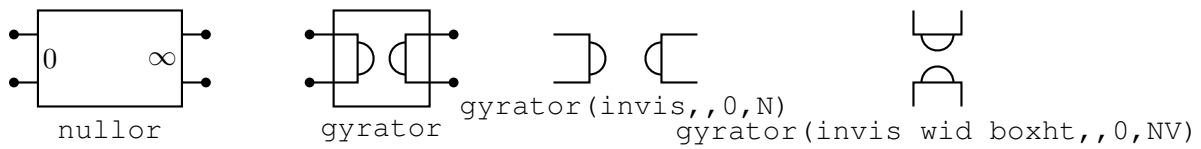


Figure 39: Some customizations of `nport` [NLG.m4].

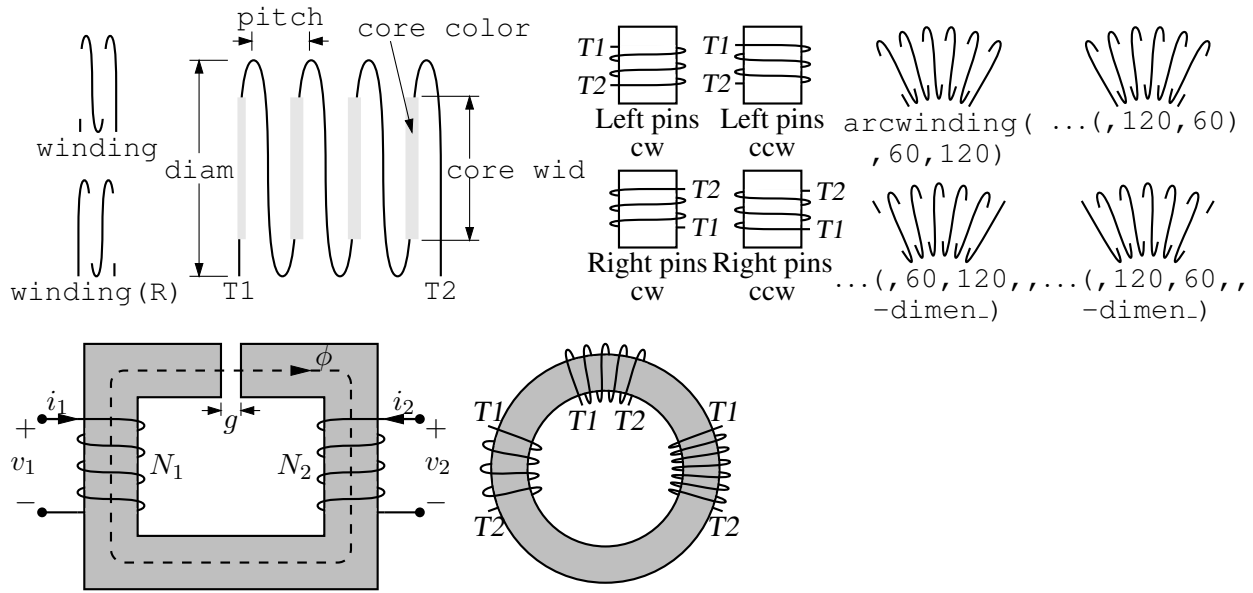


Figure 40: The macros `winding(L|R,winding diam,pitch,nturns,core wid, "core color")` and `arcwinding(winding diam, start deg, enddeg, nturns, core centre rad, core wid, "core color")` [Windings.m4].

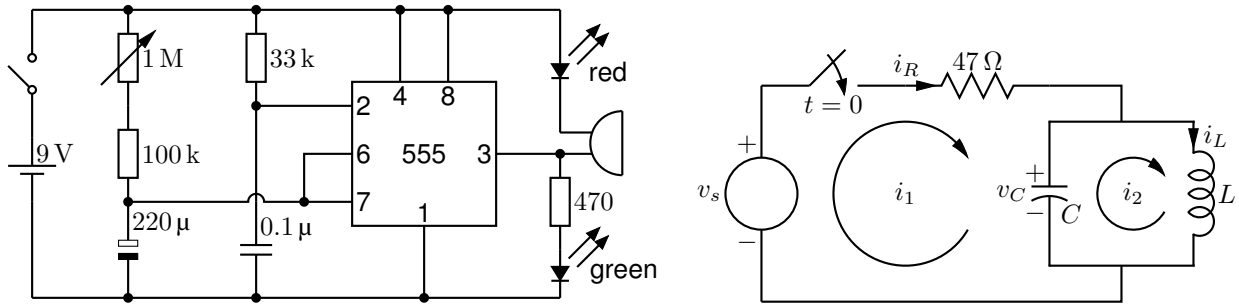


Figure 41: Two simple labeled circuits [ex01.m4].

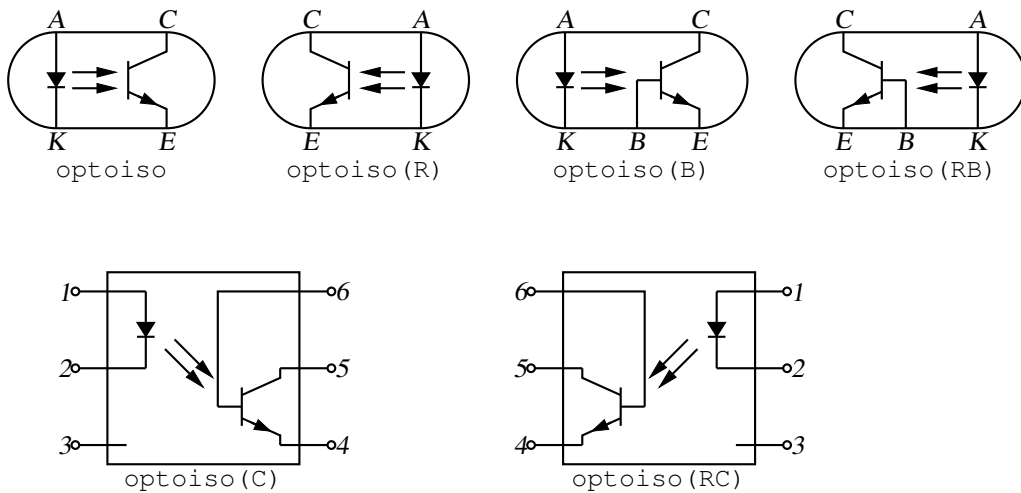


Figure 42: Optical isolator: a circuit with right or left orientation [Optoiso.m4].

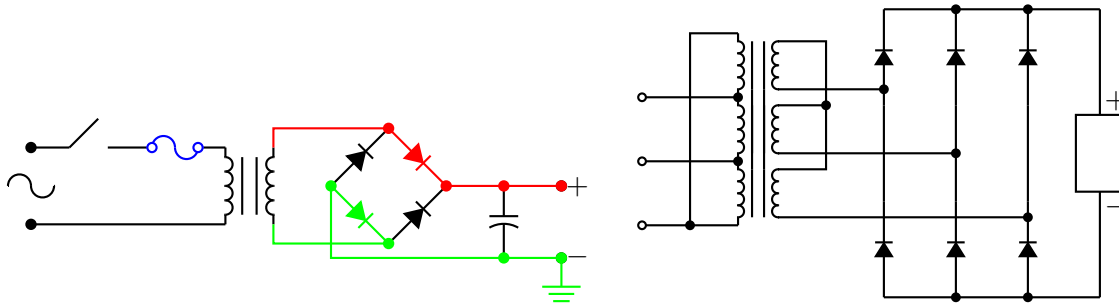


Figure 43: An elementary power supply circuit with colored elements, and a multiple-winding transformer with 3-phase rectifier [pwrsupply.m4].

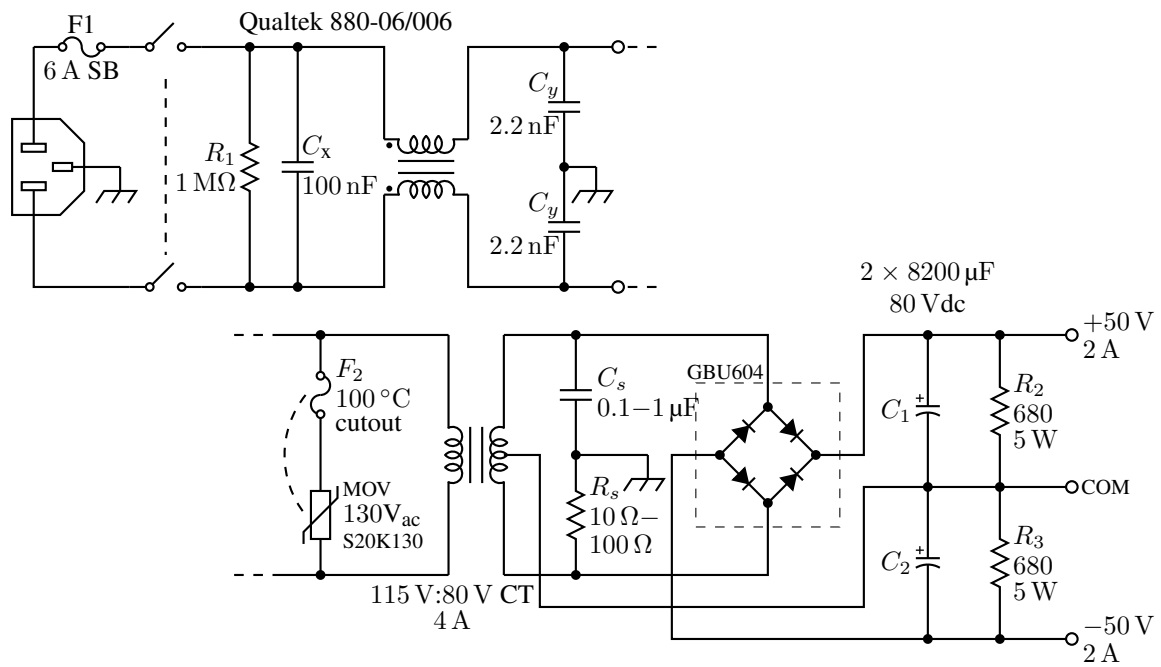


Figure 44: An unregulated 50V power supply [PS50.m4].

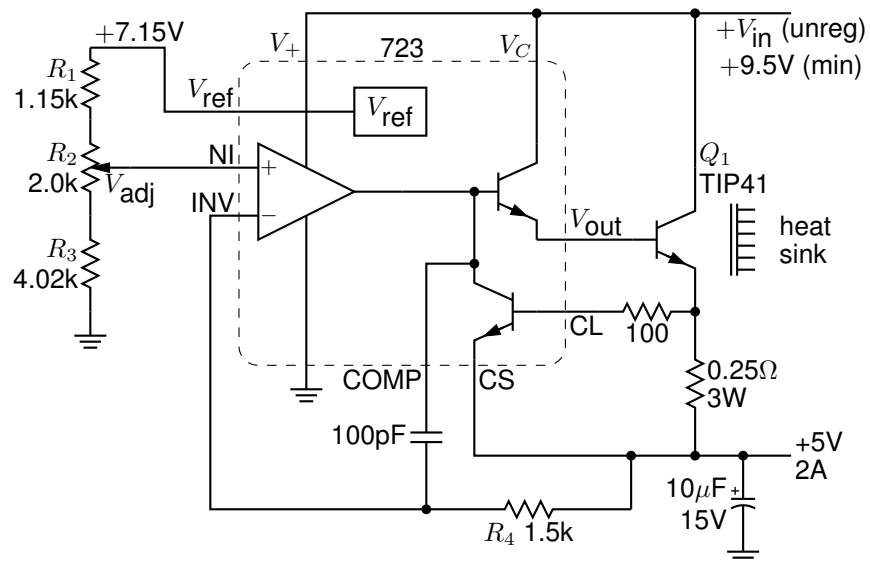


Figure 45: A 723 regulator circuit with a heat sink [Reg723.m4].

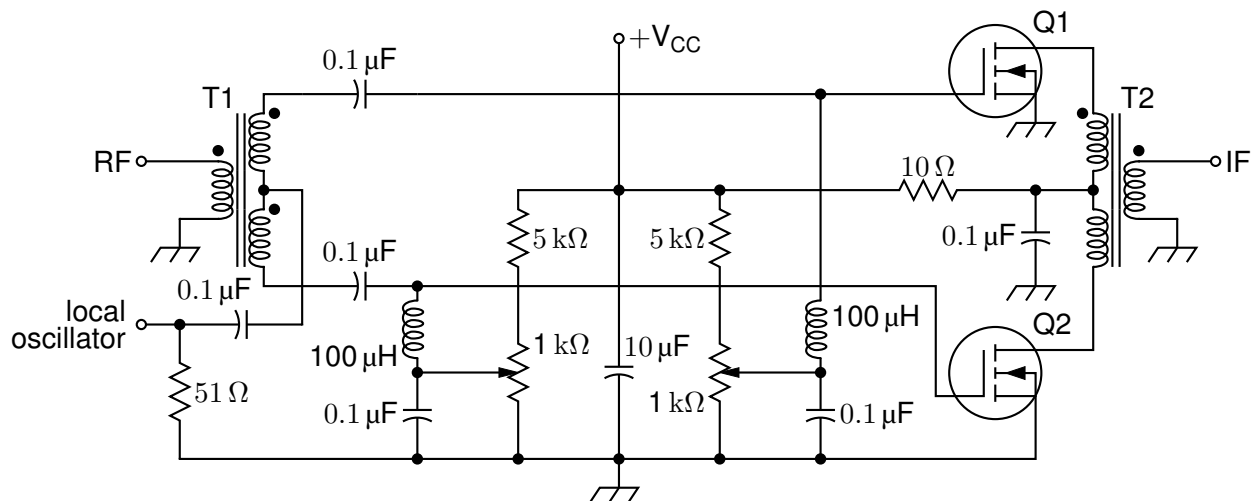


Figure 46: A balanced mixer, using mosfet and a custom transformer [Mixer.m4].

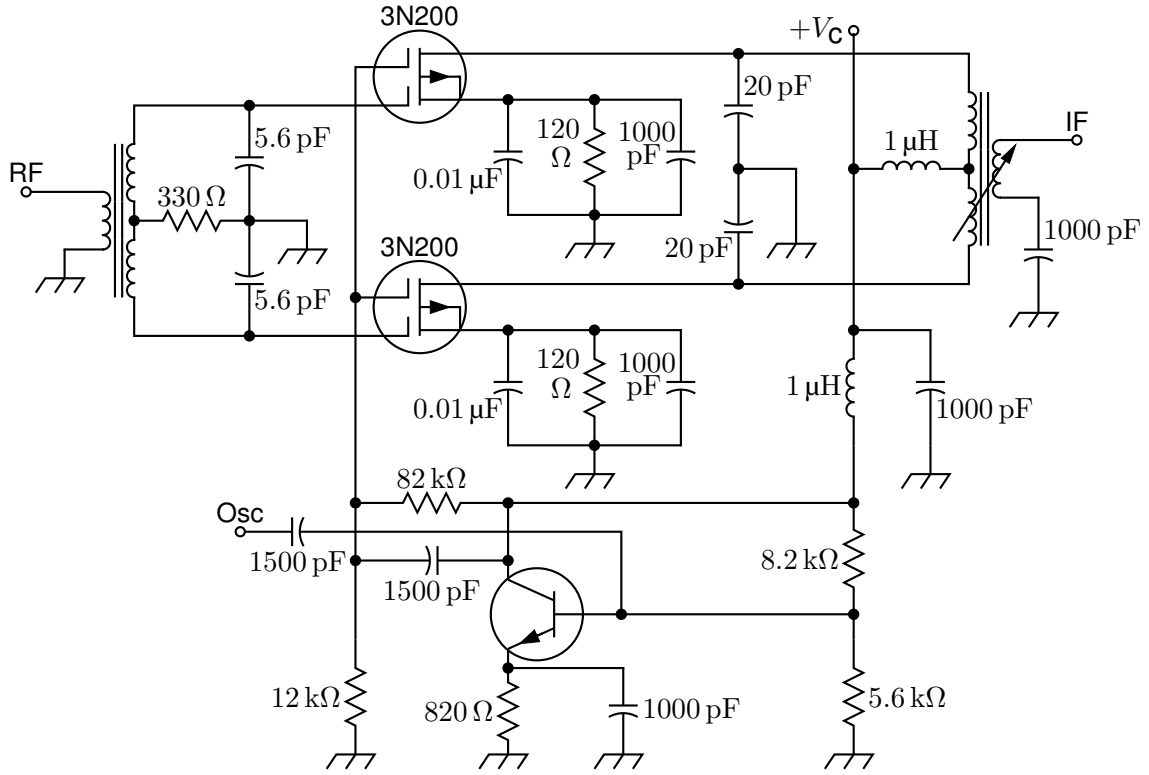


Figure 47: A push-pull mixer, showing FETs with multiple gates [PushPull.m4].

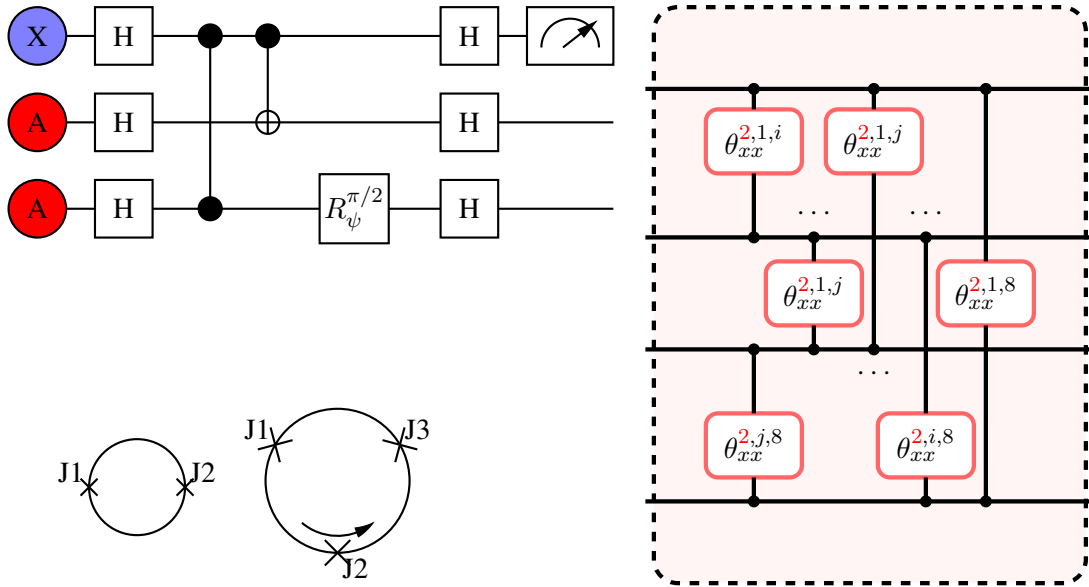


Figure 48: Quantum circuits [Quantum.m4].



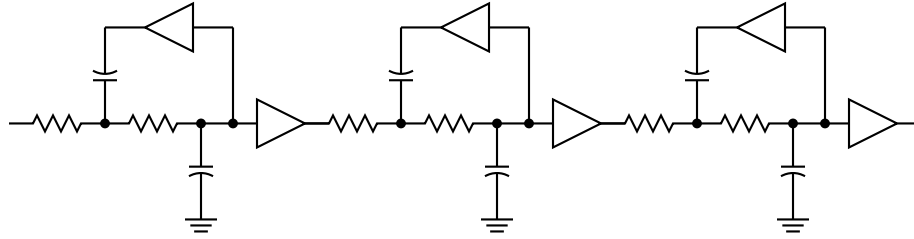


Figure 49: A six-pole filter [Sixpole.m4].

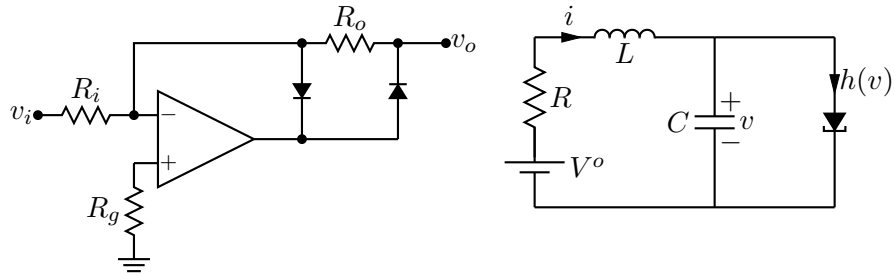


Figure 50: Precision half-wave rectifier and a tunnel diode circuit (illustrating opamp, diode, resistor, ground, and labels) [ex18.m4].

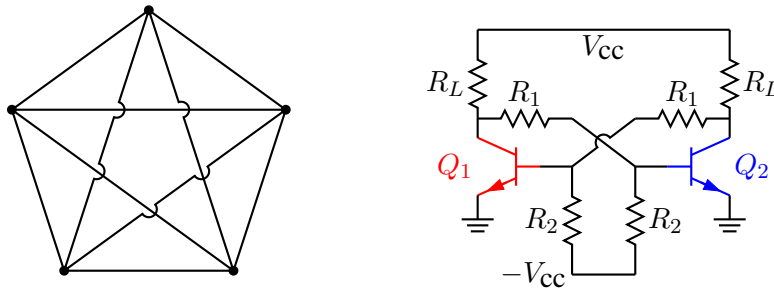


Figure 51: Non-planar graph and bistable circuit (illustrating the crossover macro and colored elements) [ex10.m4].

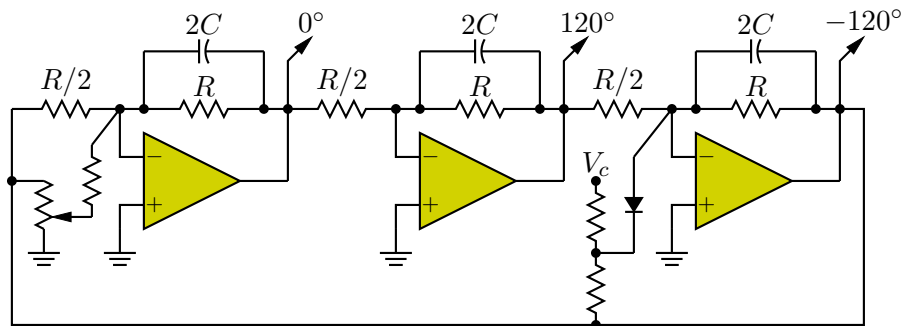


Figure 52: Three-phase oscillator [Three.m4].

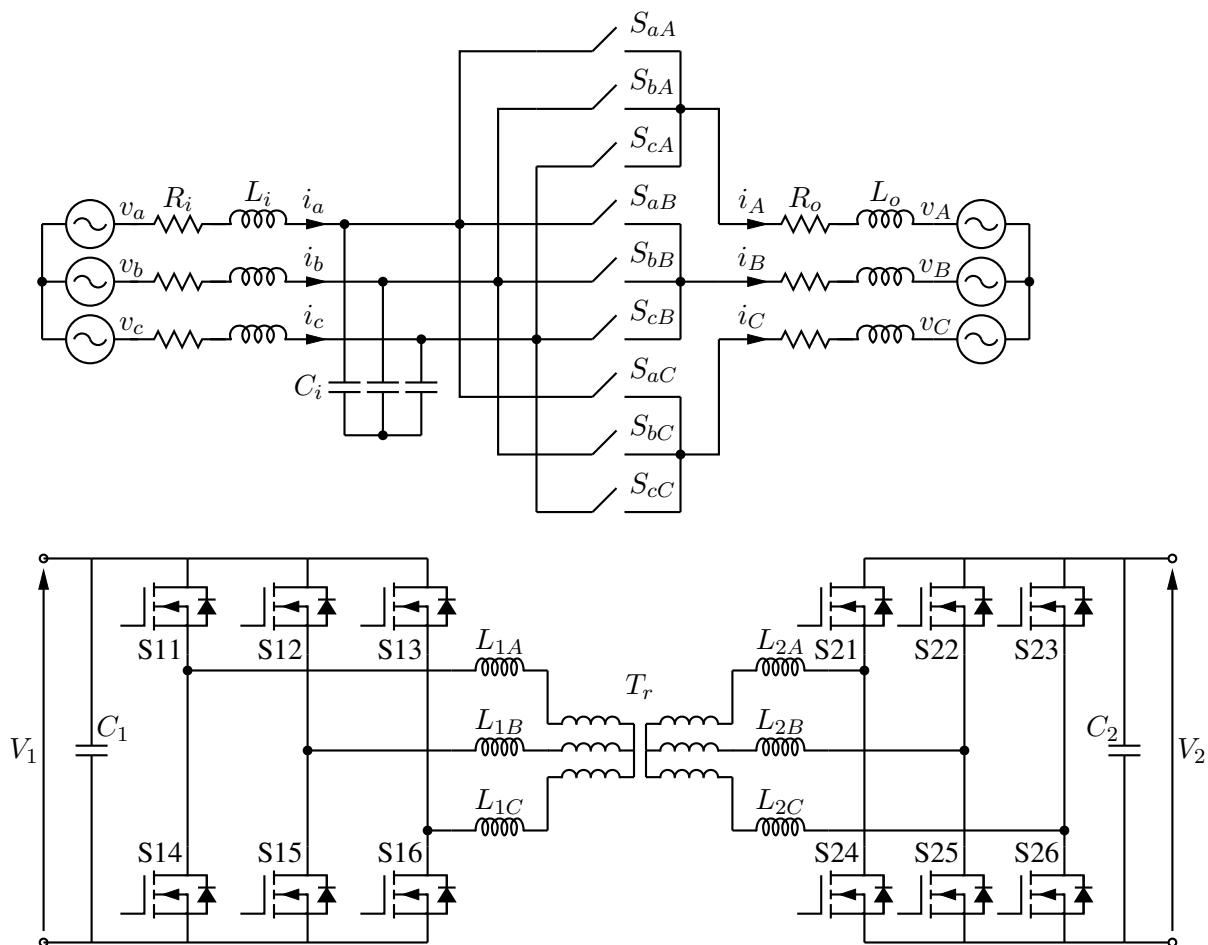


Figure 53: A three-phase switched AC-AC converter and a DC-DC converter [MC.m4].

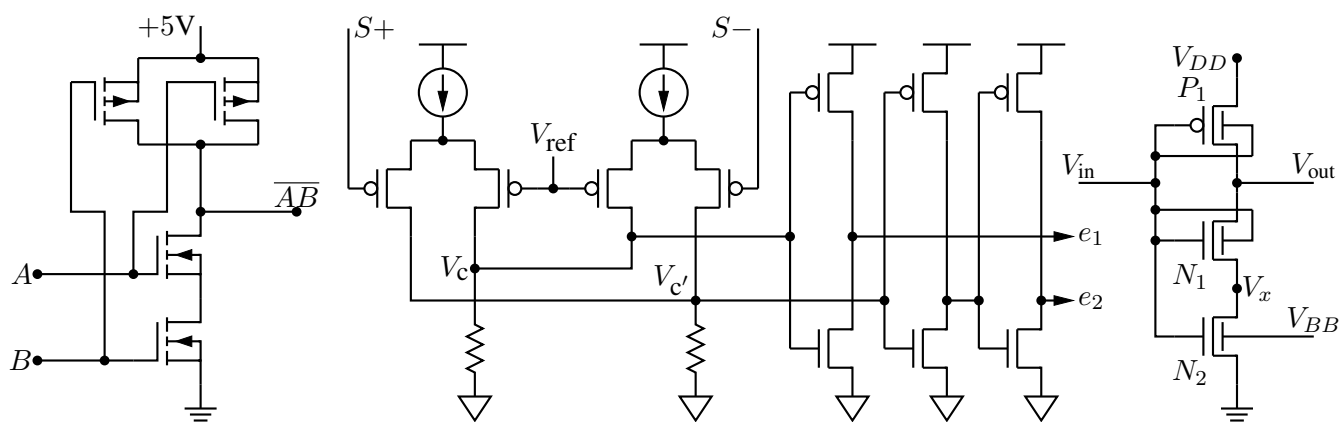


Figure 54: A CMOS NAND gate, a test circuit, and an XMOSEFET example [ex12.m4].

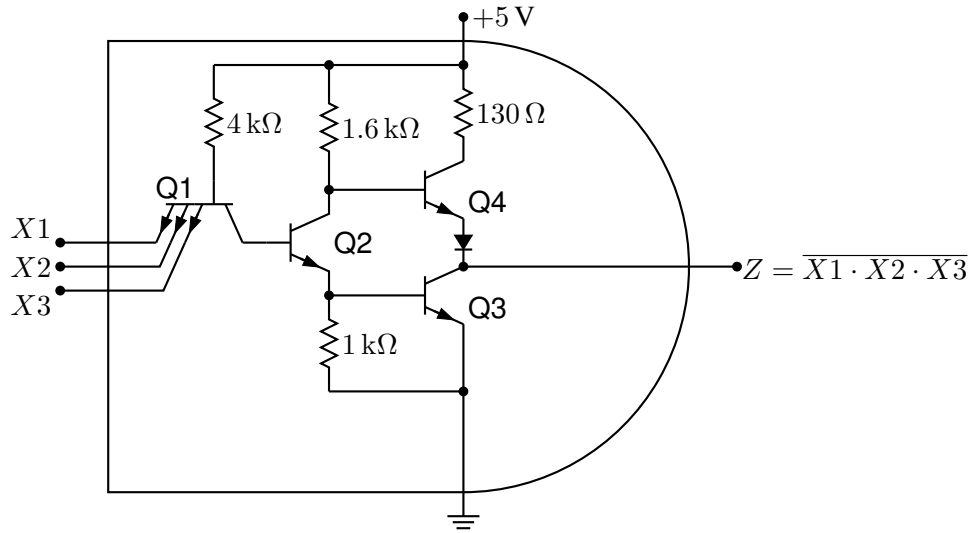


Figure 55: TTL NAND gate illustrating a transistor with multiple emitters [TTLnand.m4].

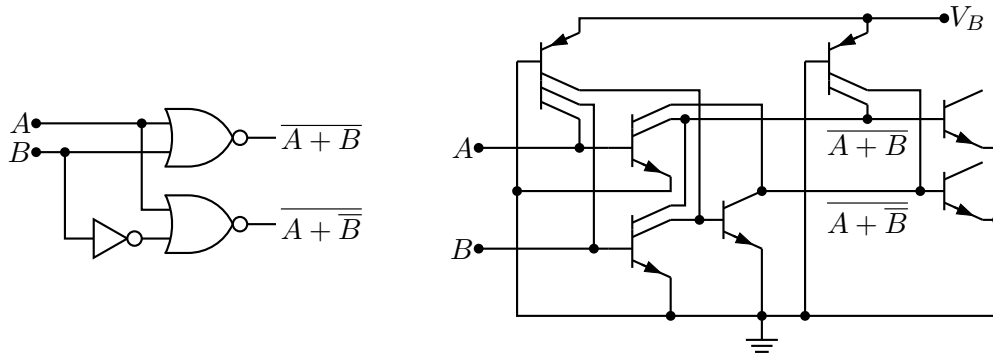


Figure 56: Gate circuit and equivalent embedded  $I^2L$  components illustrating multiple collectors [I2L.m4].

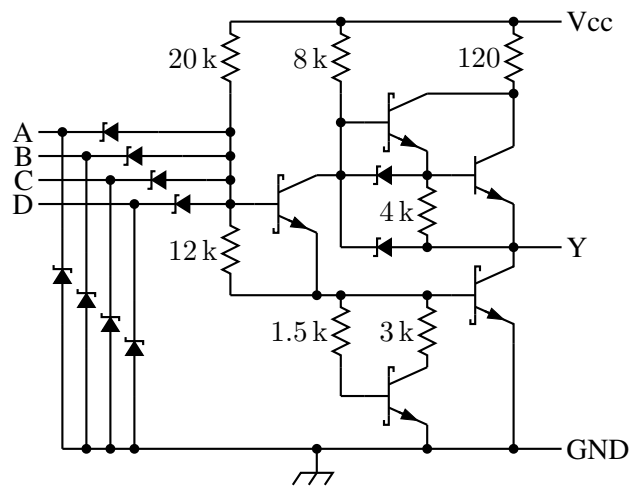


Figure 57: A 4-input NAND circuit illustrating the S (Schottky) option of bi\_trans [Schottky.m4].

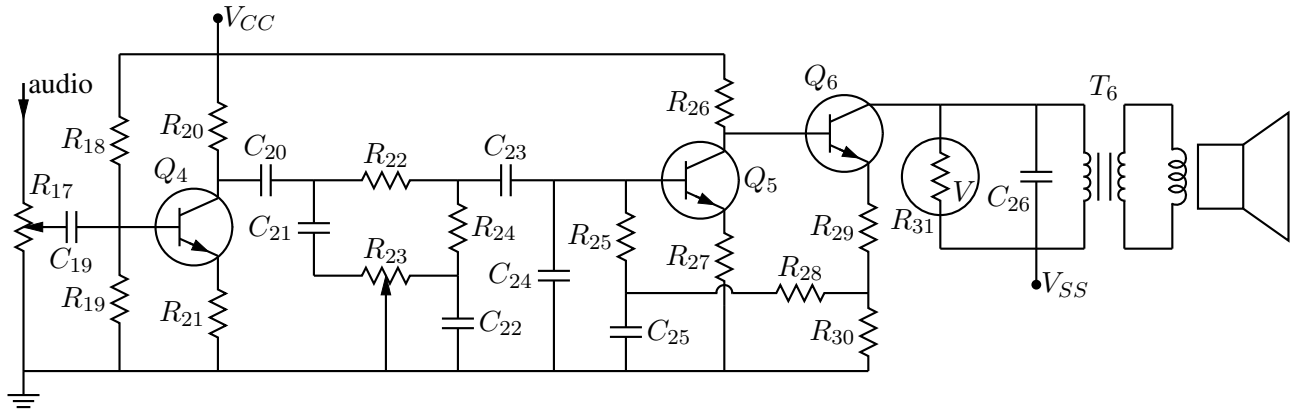


Figure 58: Transistor radio audio chain [ex11.m4].

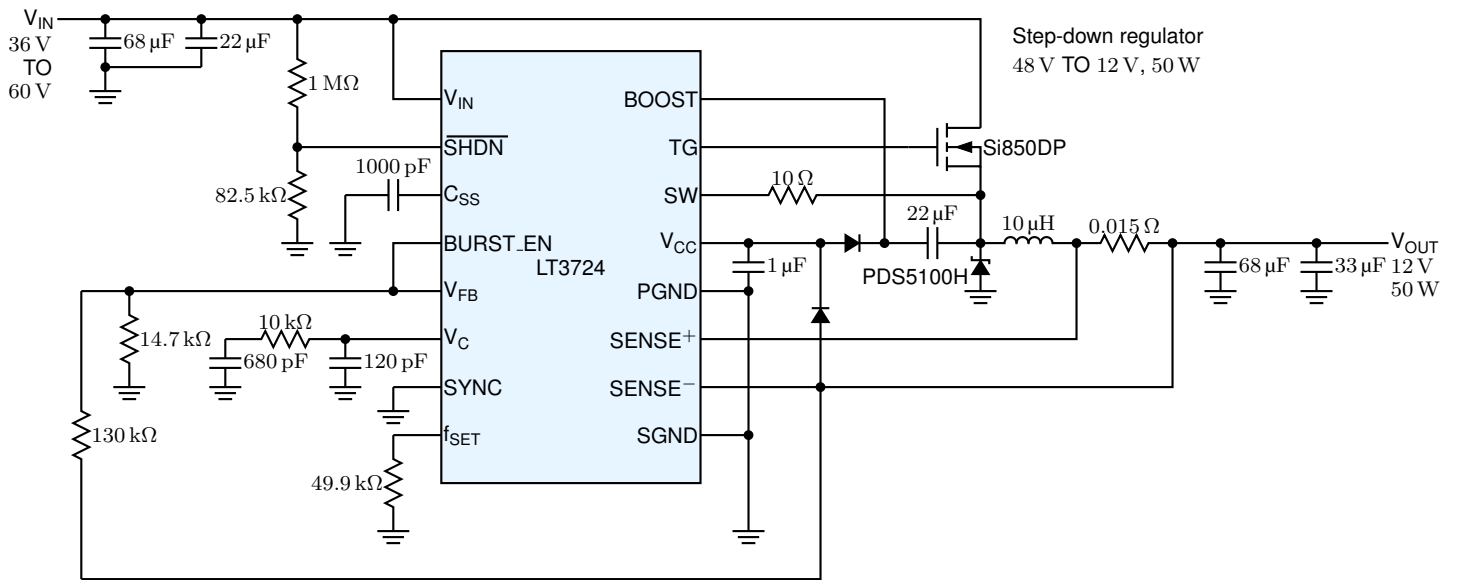


Figure 59: IC controller and auxiliary elements of a step-down converter [LT3524.m4].

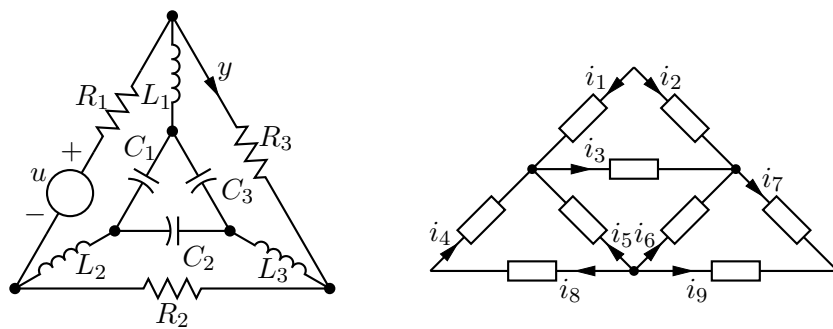


Figure 60: Labels on non-manhattan elements [ex04.m4].

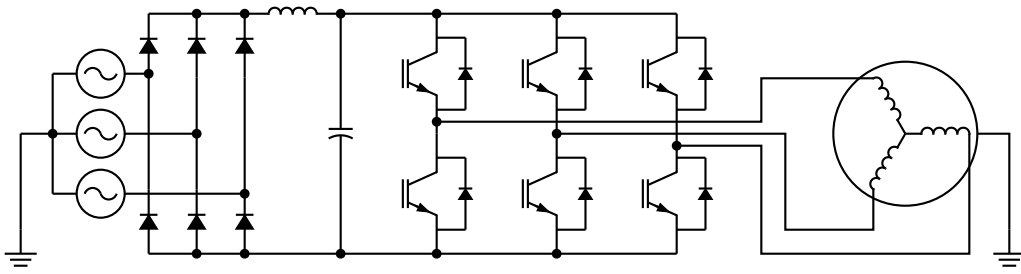


Figure 61: Synchronous machine driven by variable-speed drive and rectifier [Drive.m4].

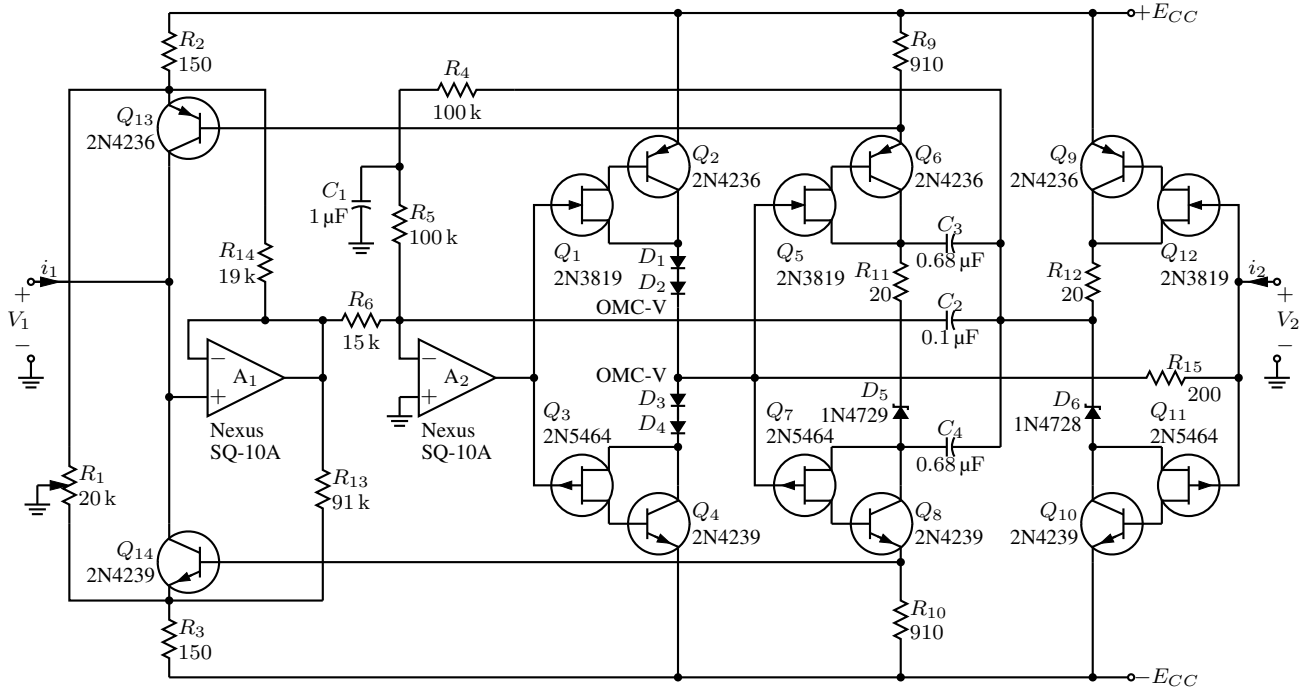


Figure 62: Realization of a controlled source (illustrating stacked element labels) [Csource.m4].

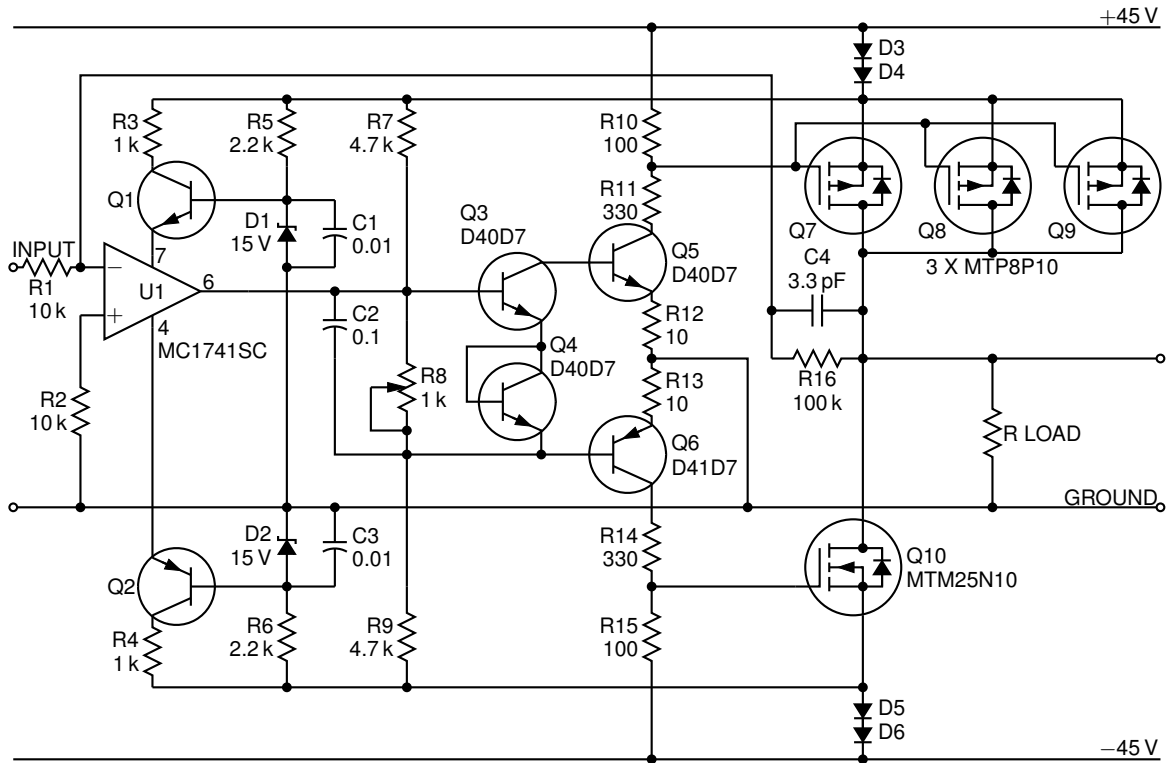


Figure 63: A 50 W audio amplifier [AudioAmp.m4].

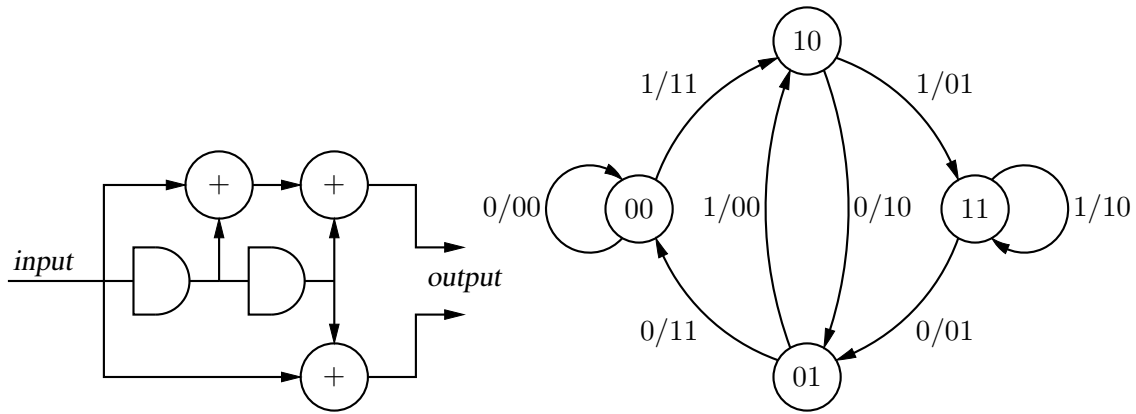


Figure 64: A rate 1/2 binary convolutional coder and its state diagram [ex16.m4].

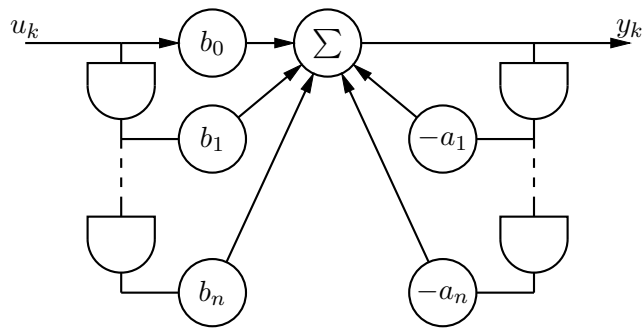


Figure 65: Digital filter [ex03.m4].

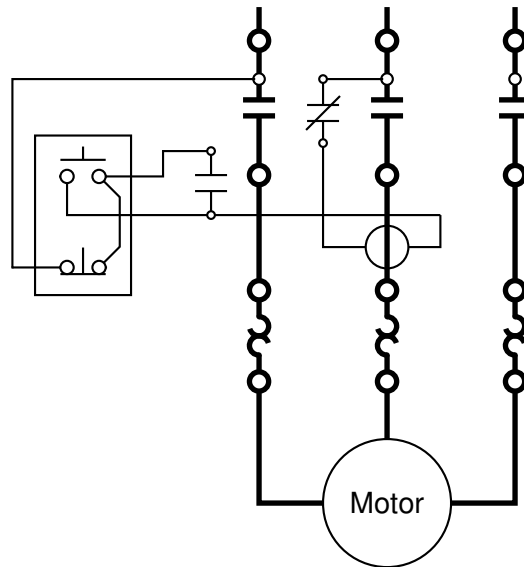


Figure 66: Motor control connections [MotorControl.m4].

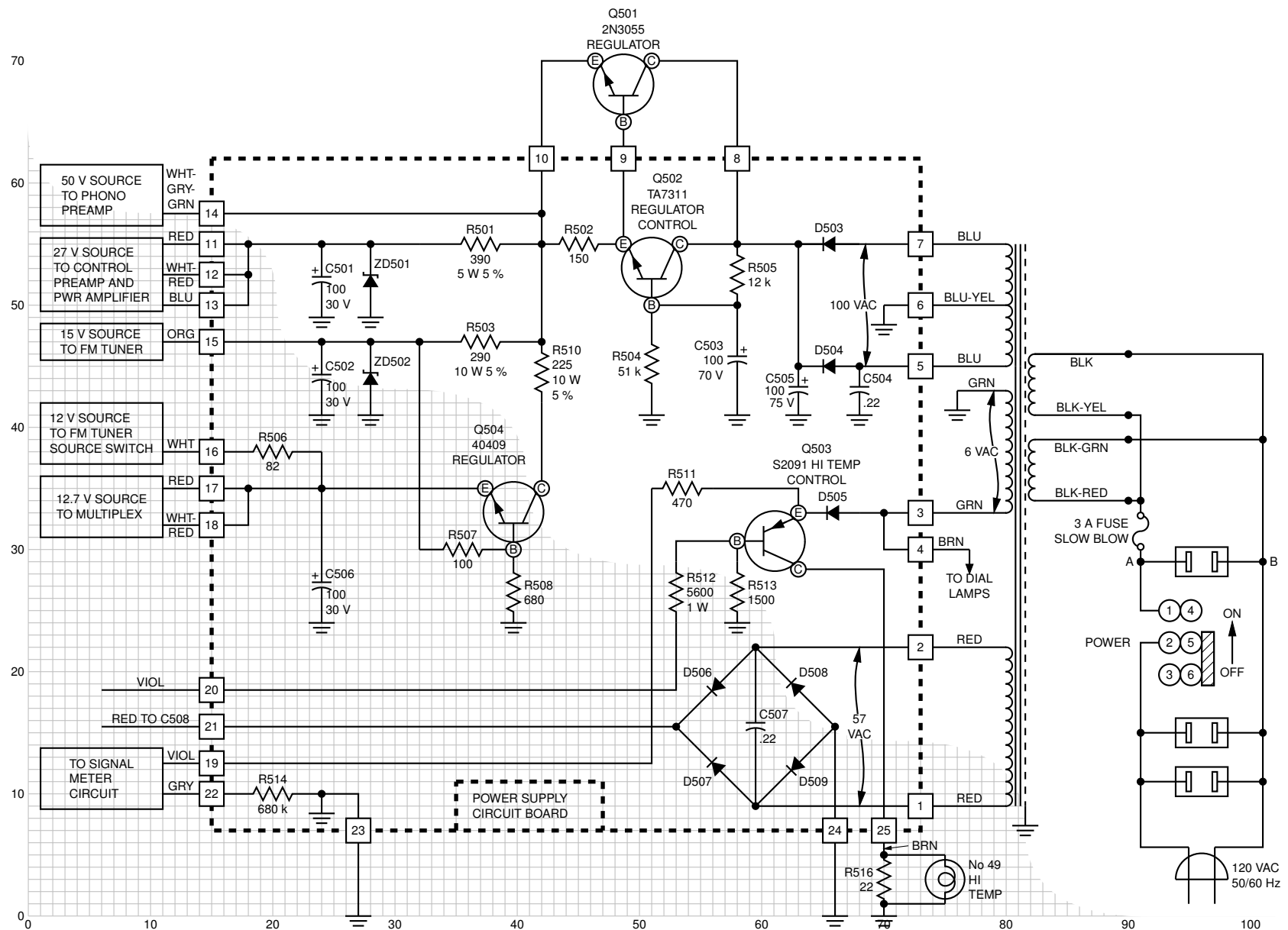


Figure 67: The power supply of a Heathkit AR-15 (Now, *that* was a receiver!) with custom transformer and other elements, drawn on a grid (partially shown) to aid in placement [Heathkit.m4].



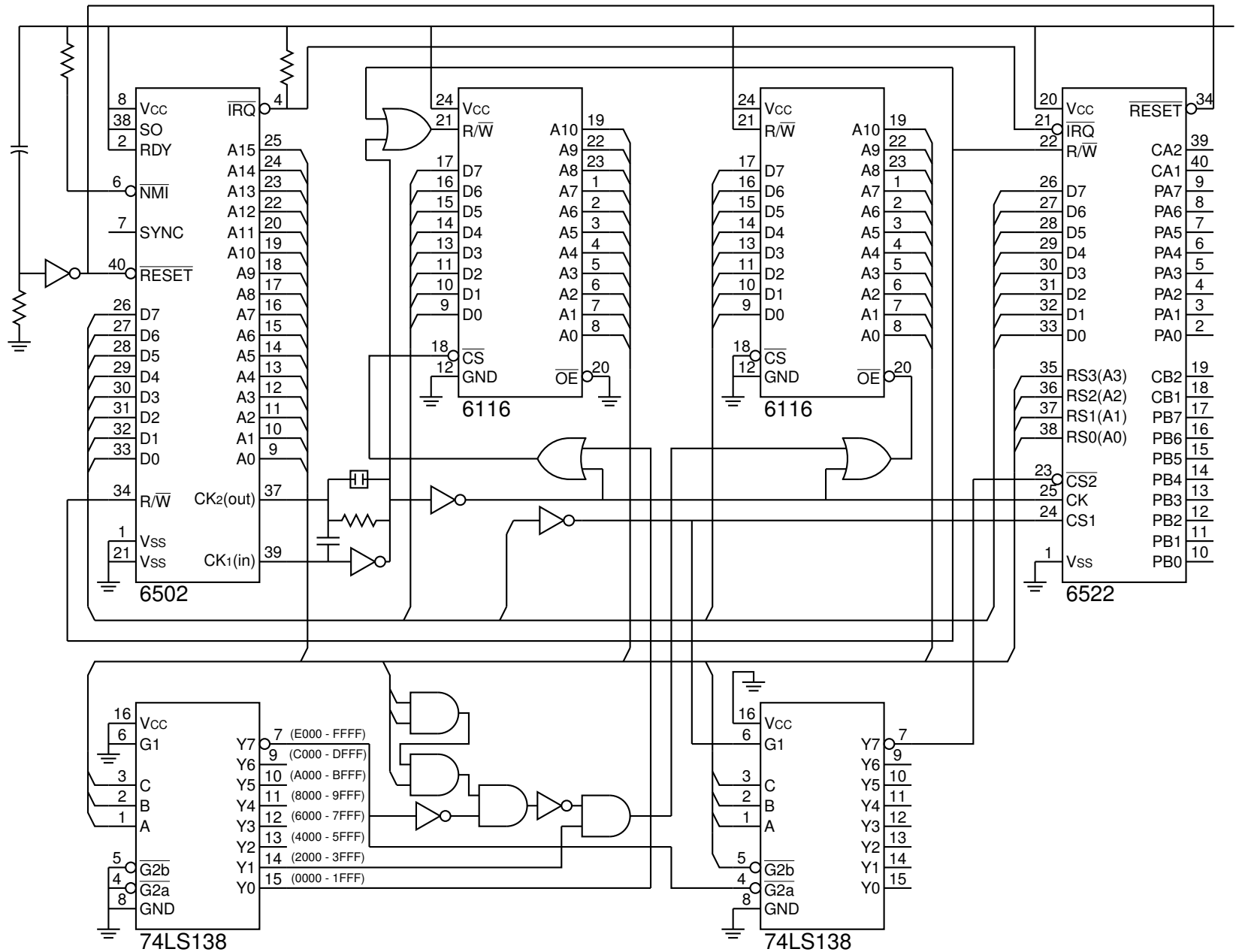


Figure 68: A digital circuit of moderate size, redrawn from M. P. MacIenlan and G. M. Burns, "An Approach to Drawing Circuit Diagrams for Text Books," Tugboat (12)1, March 1991, pp. 66-69 [lcct.m4].

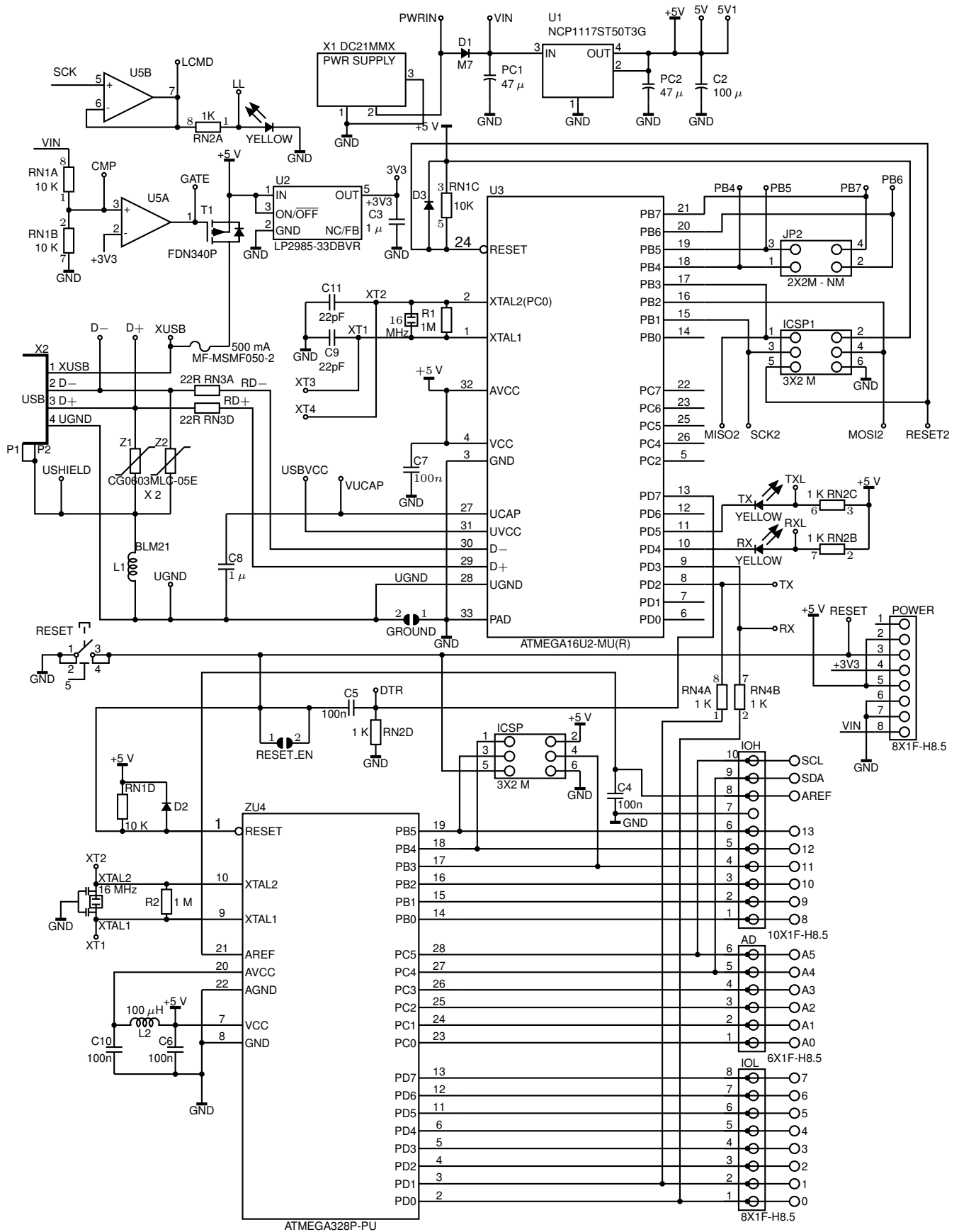


Figure 69: An Arduino UNO circuit adapted and redrawn [ UNO .m4 ].

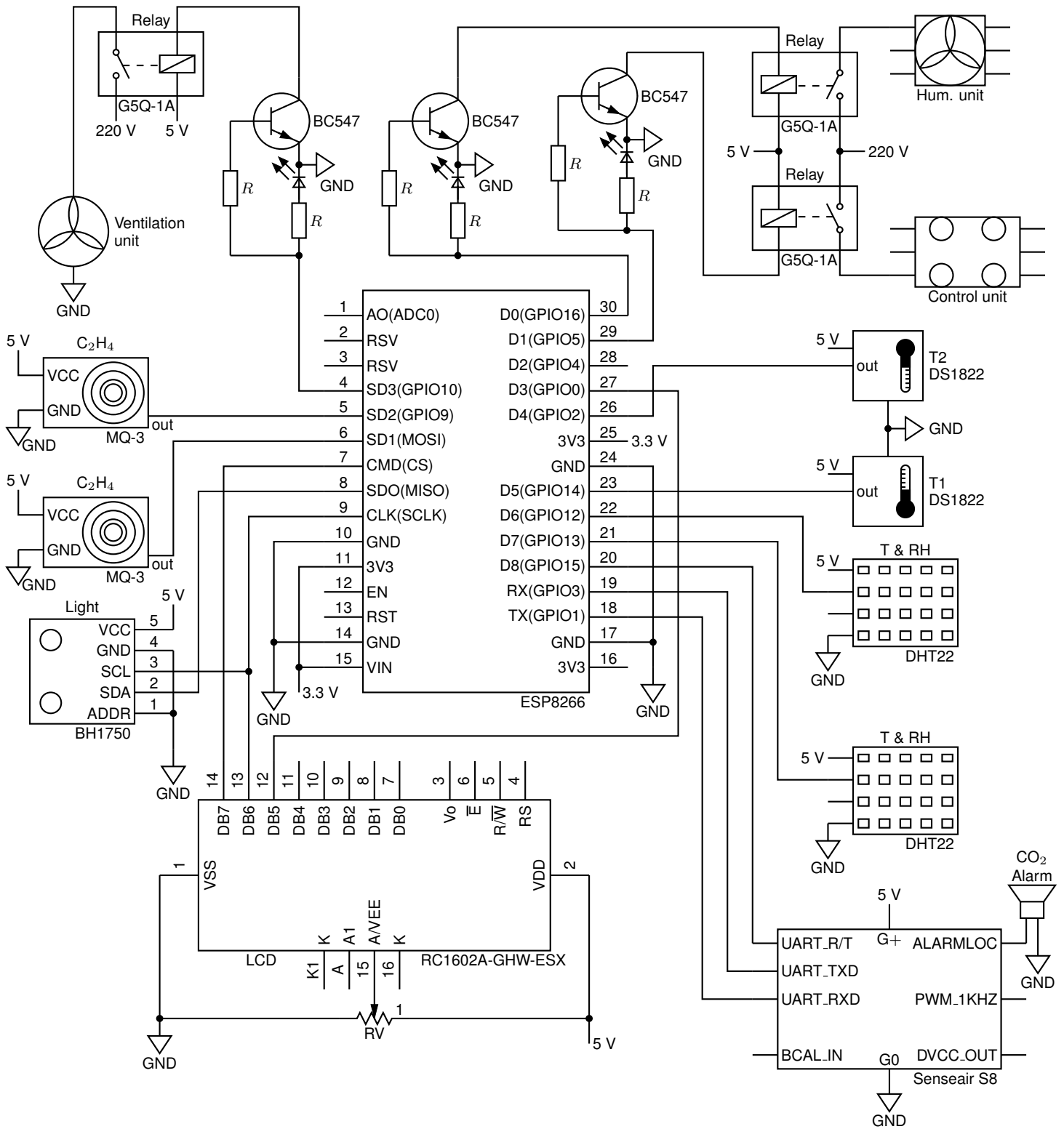


Figure 70: Part of a cold room controller, with some custom sensors [ColdControl1.m4].



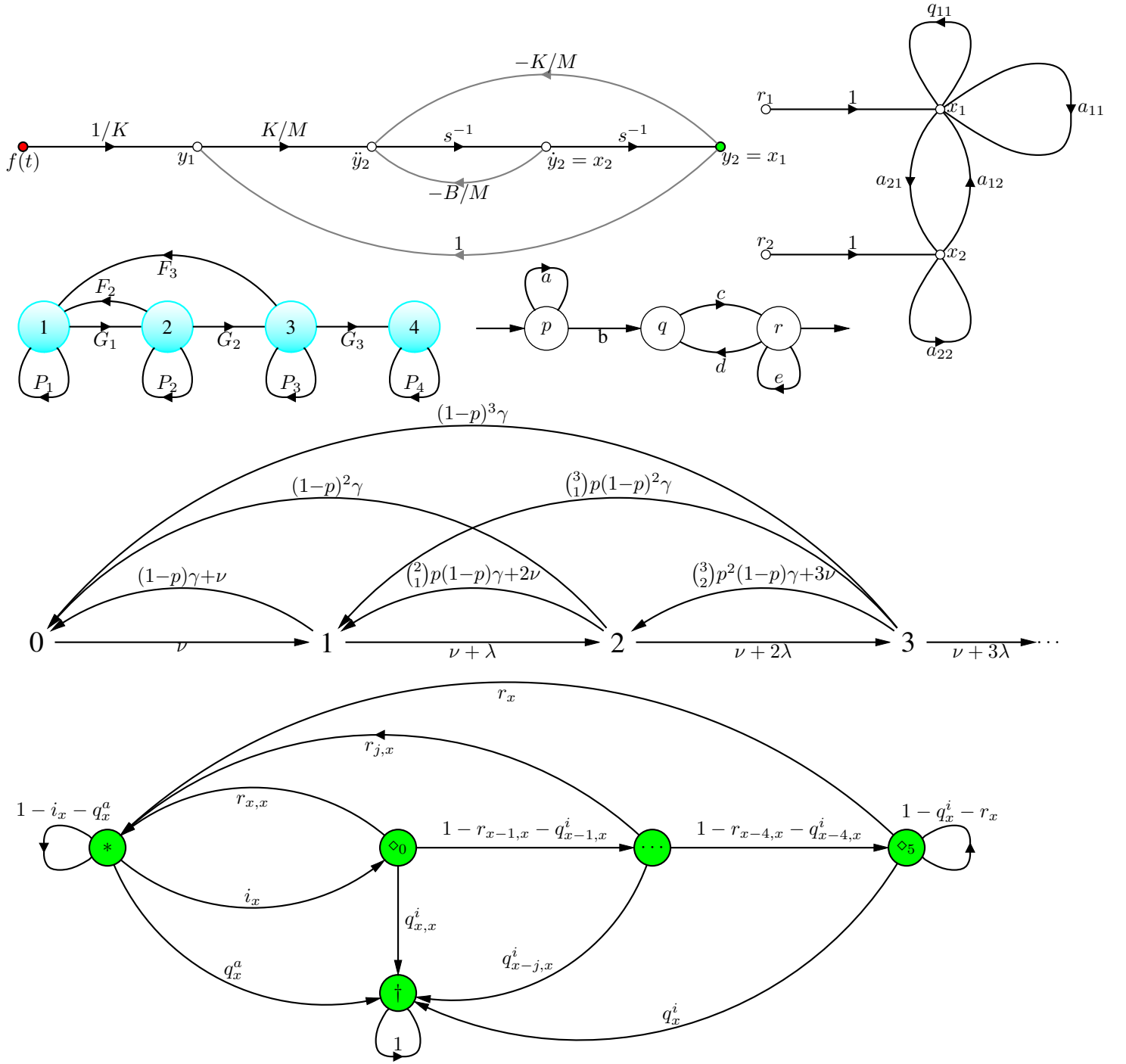


Figure 72: Signal-flow graphs [sf g.m4].

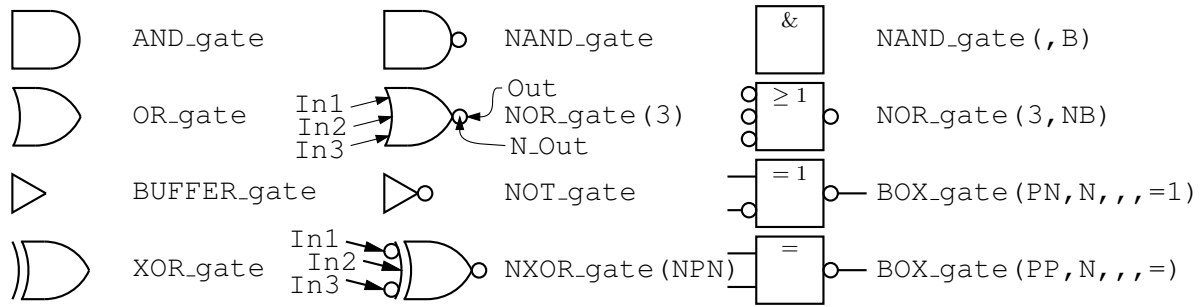


Figure 73: Basic logic gates [Logic.m4].

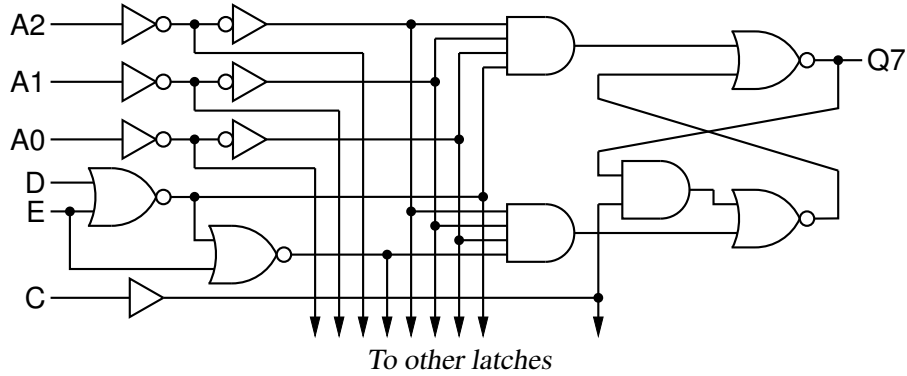


Figure 74: General-purpose latch: a small logic circuit [ex08.m4].

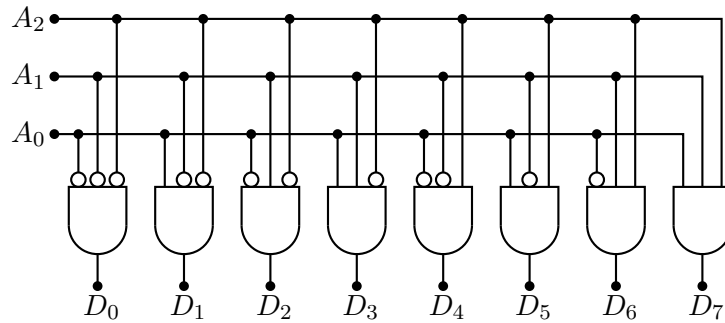


Figure 75: Decoder logic, constructed using the `for_macro` [Decoder.m4].

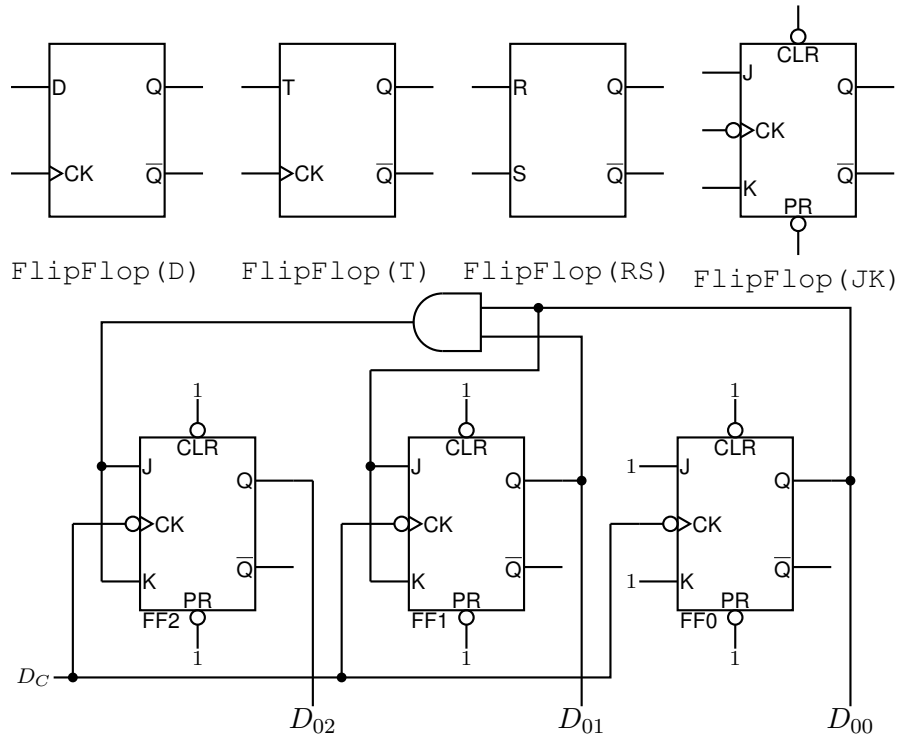


Figure 76: Some flip-flops [ex21.m4].

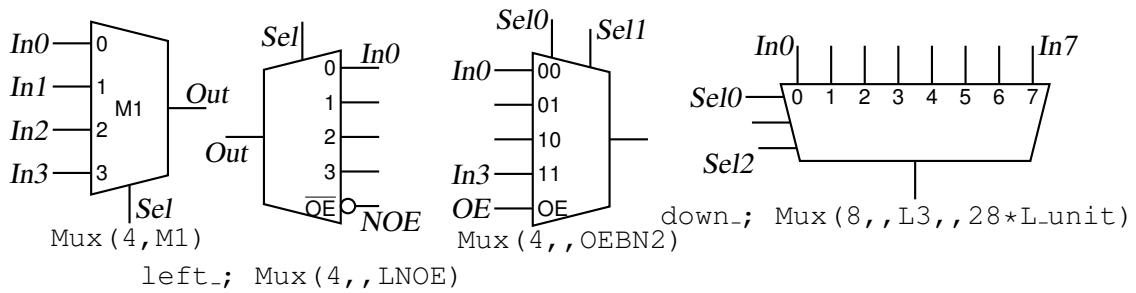


Figure 77: Multiplexer [Multiplexer.m4].

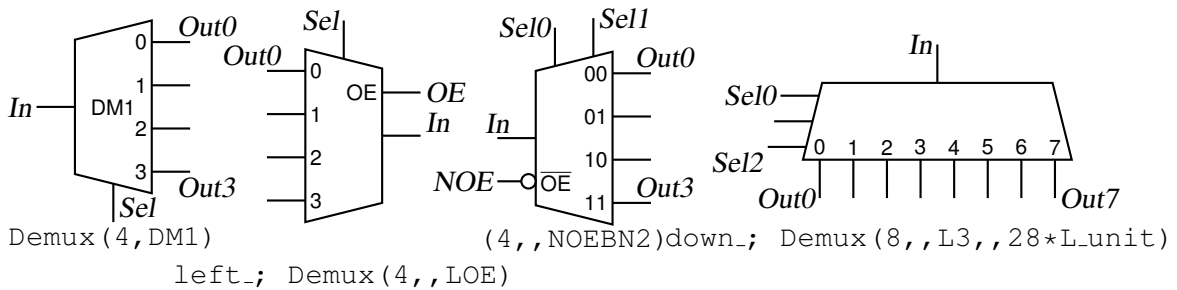


Figure 78: Demultiplexer [Demultiplexer.m4].

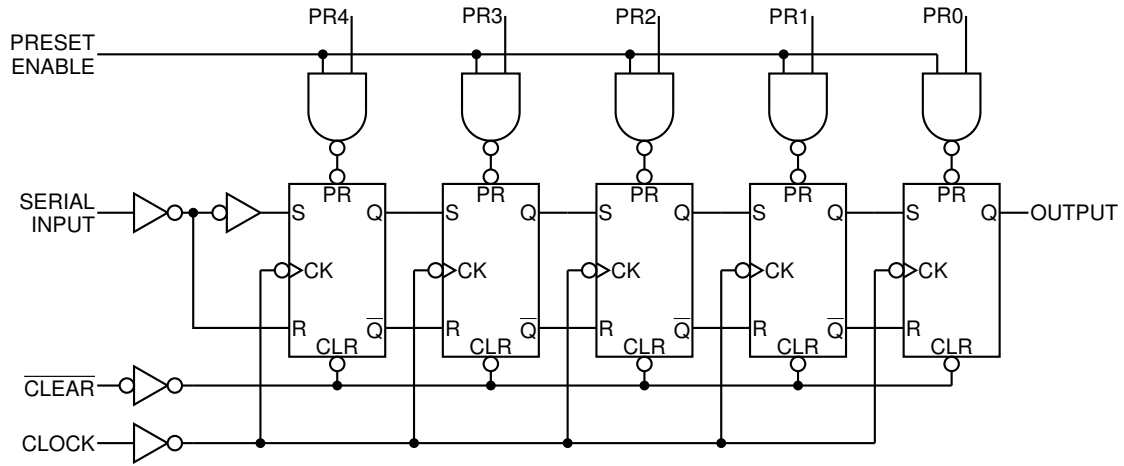


Figure 79: A 5-bit shift register drawn using a custom flip-flop [ShiftR.m4].

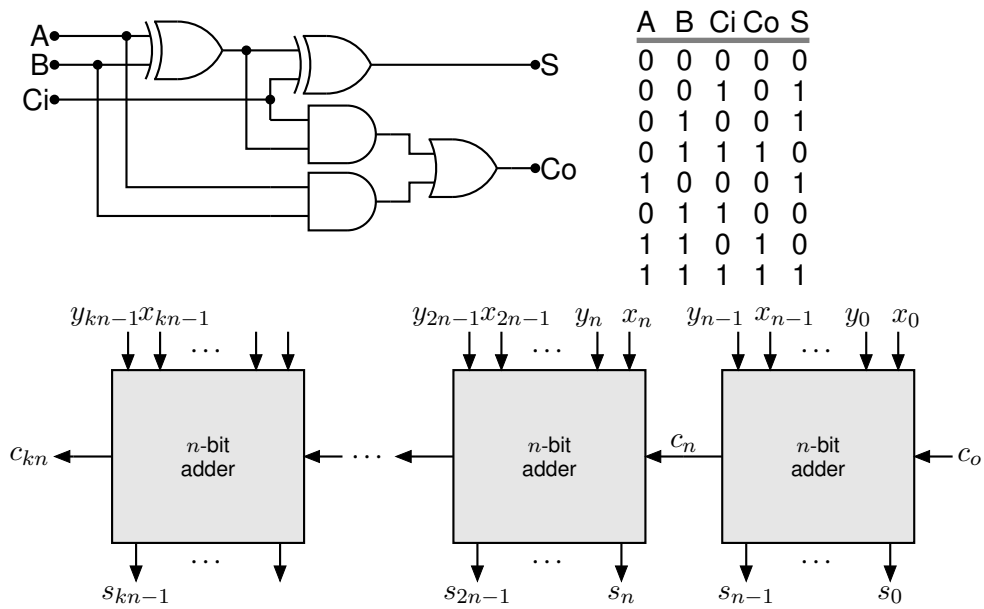
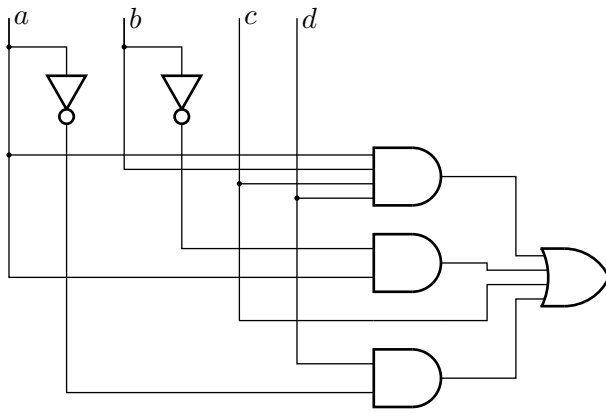
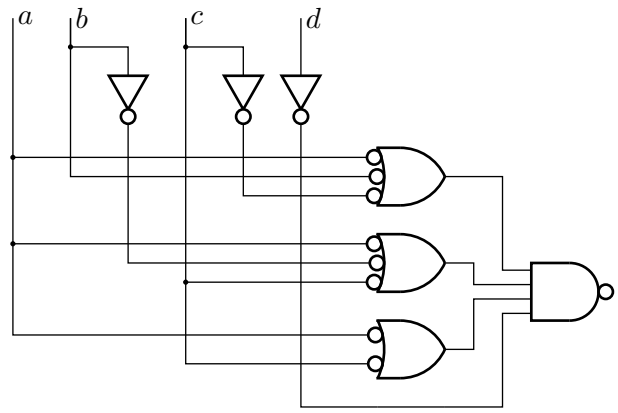


Figure 80: A full adder and a cascade of  $n$ -bit adders [Adder.m4].





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



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

Figure 81: A way of automatically drawing two-layer logic diagrams [CanLogic.m4].

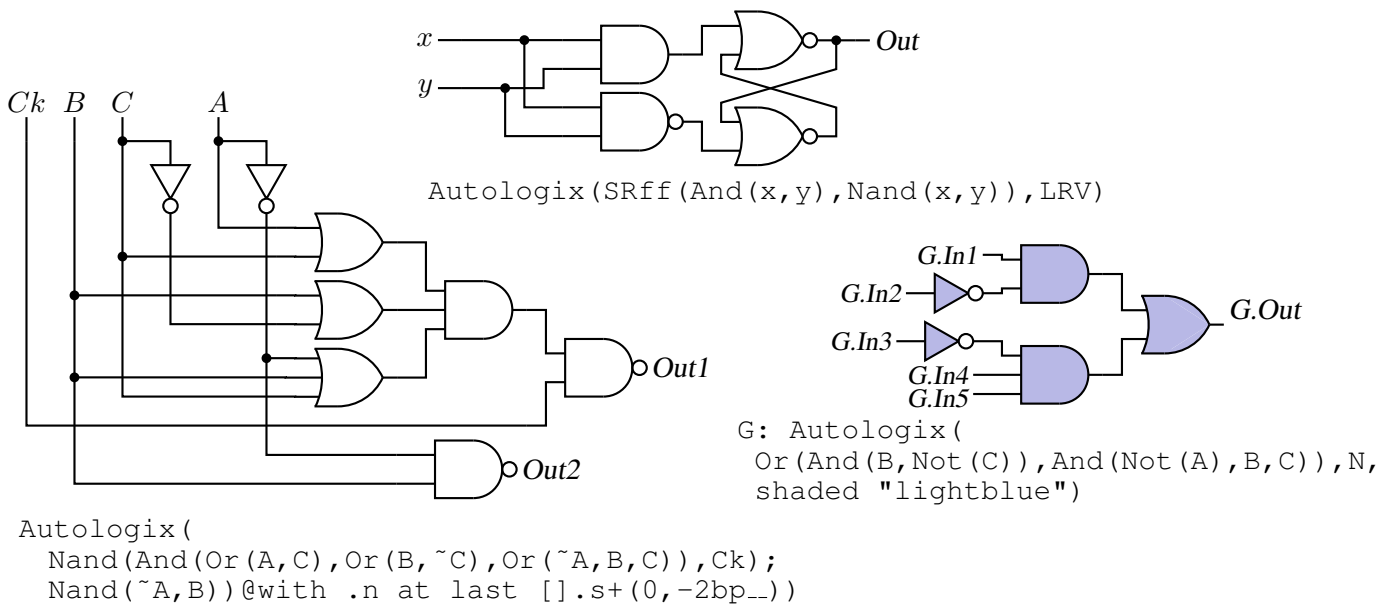


Figure 82: The Autologix (*Boolean expression; Boolean expression... , options*) macro automatically draws Boolean expressions in function notation. The function tree is drawn, then a row or column of inputs, then the connections. The default result is on the left, a custom element at the top, and a tree of gates only is shown on the right. [Alogix.m4].

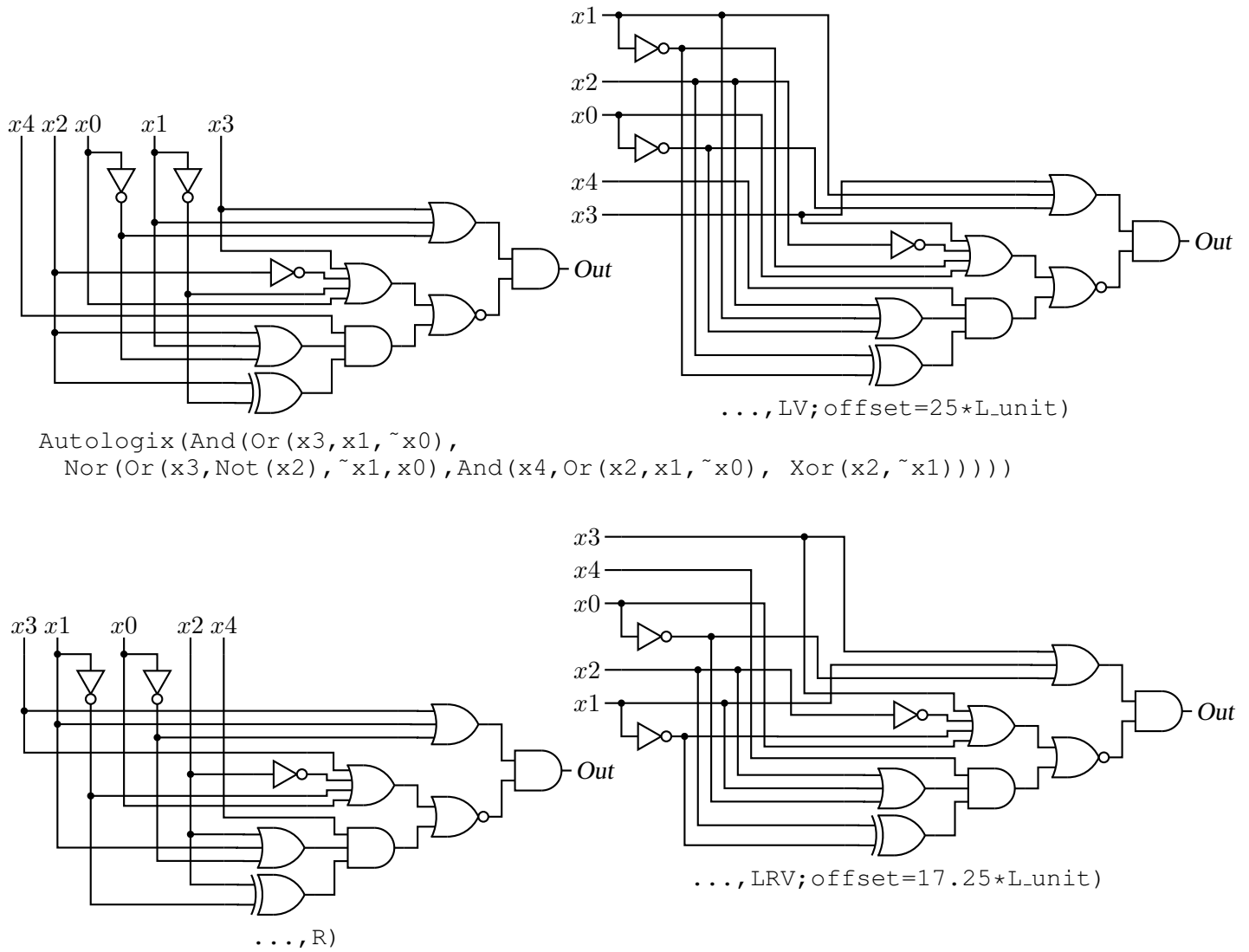


Figure 83: The Autologix macro can draw inputs on the left but the added drawing complexity may require hand tuning with second-argument options: L puts the inputs on the left, R reverses their order, V scans the input arguments in reverse order, and offset=value displaces the array of inputs [ABlogix.m4].

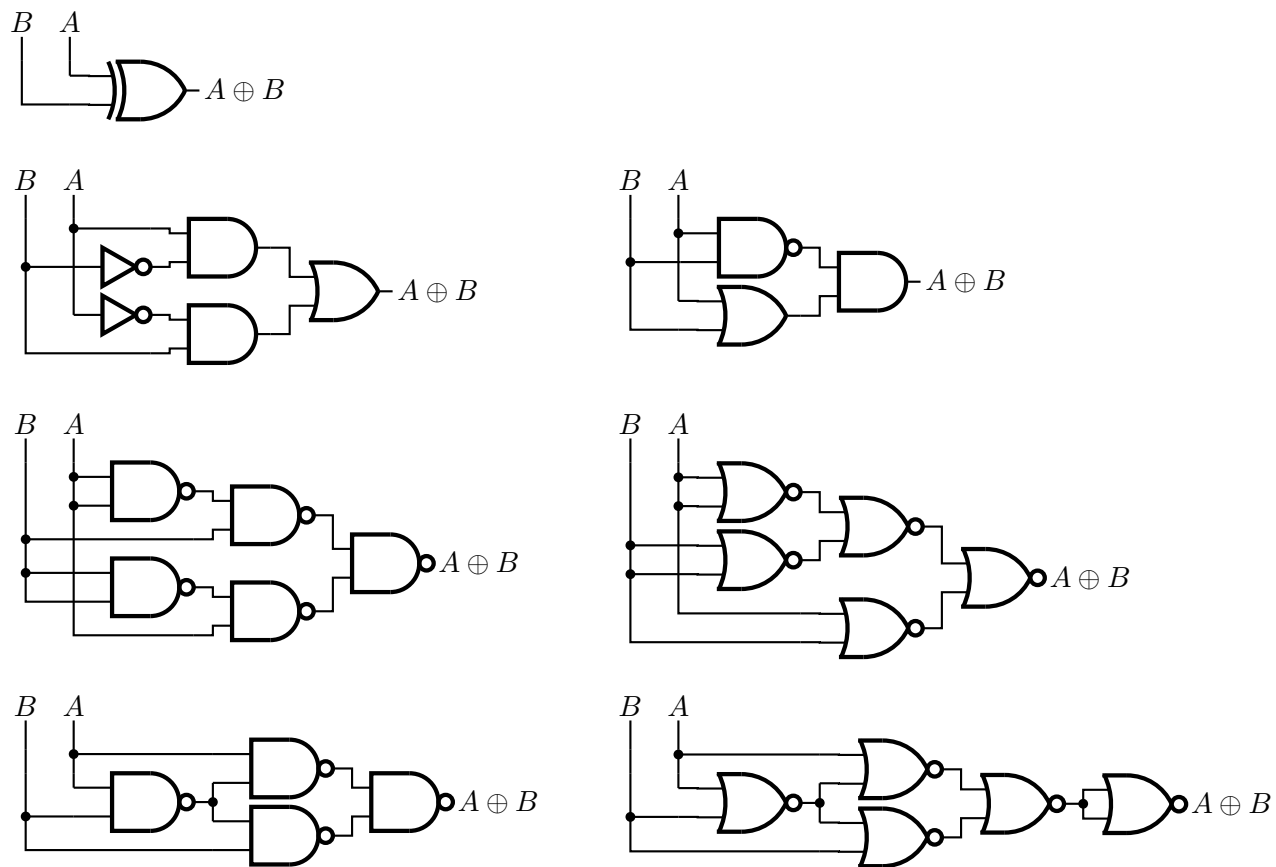


Figure 84: Realizations of the XOR function using Autologix [XOR.m4].

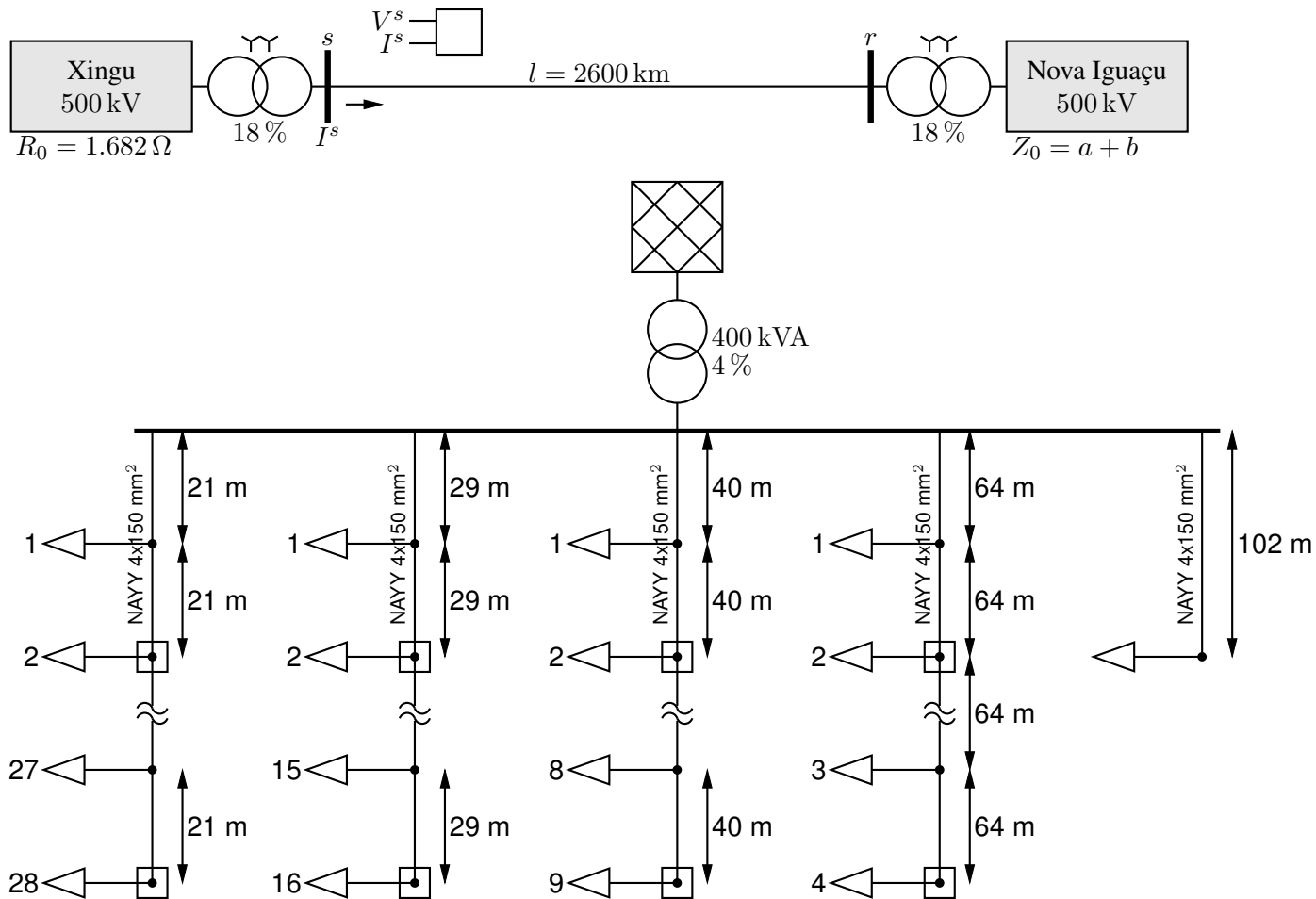


Figure 85: A single-line distribution diagram [OneLine.m4].

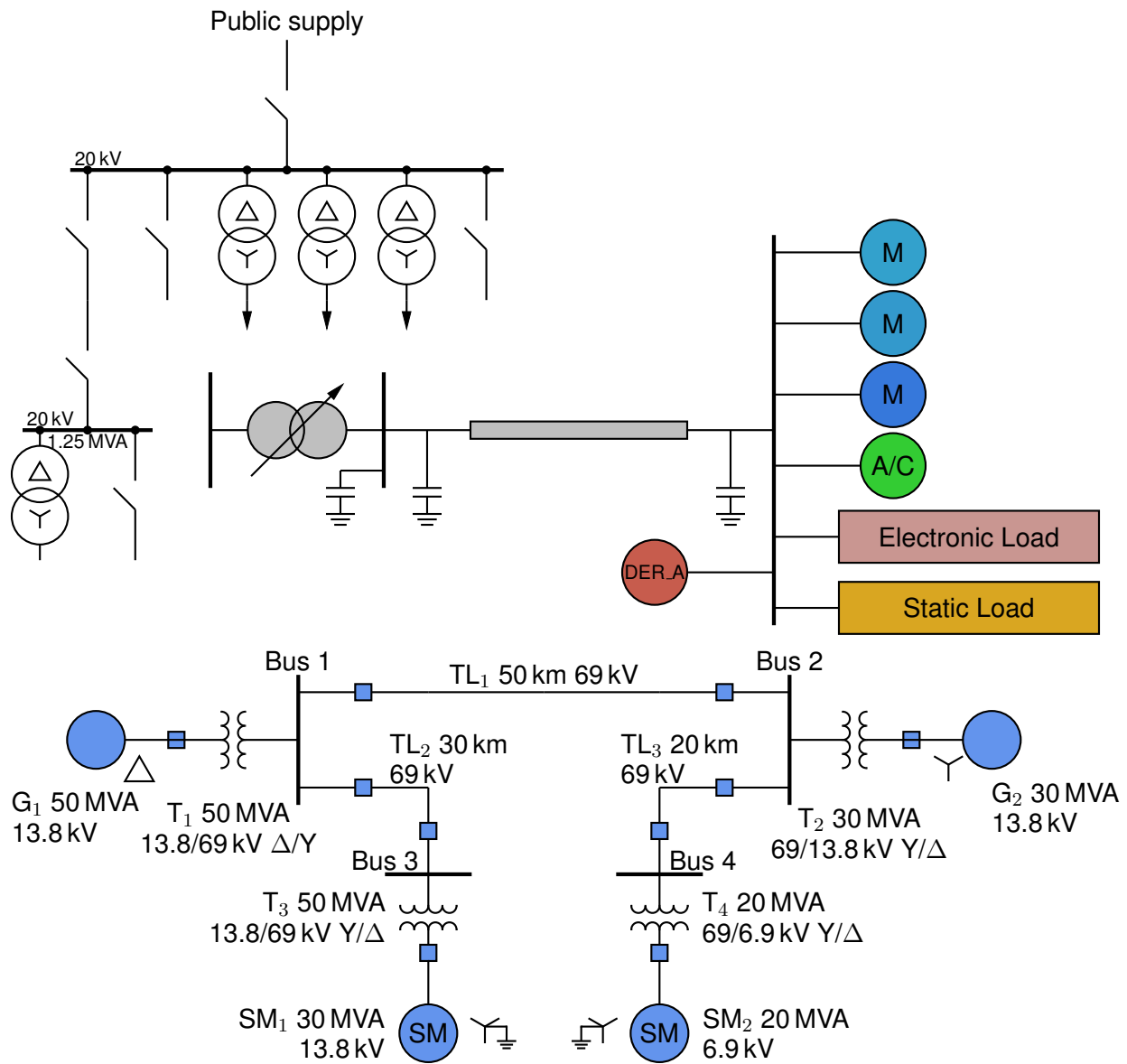
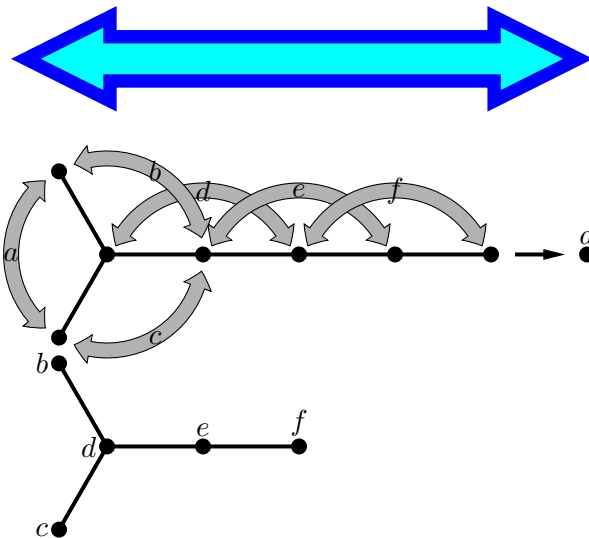
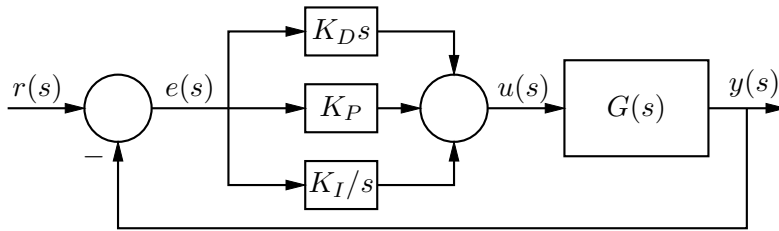


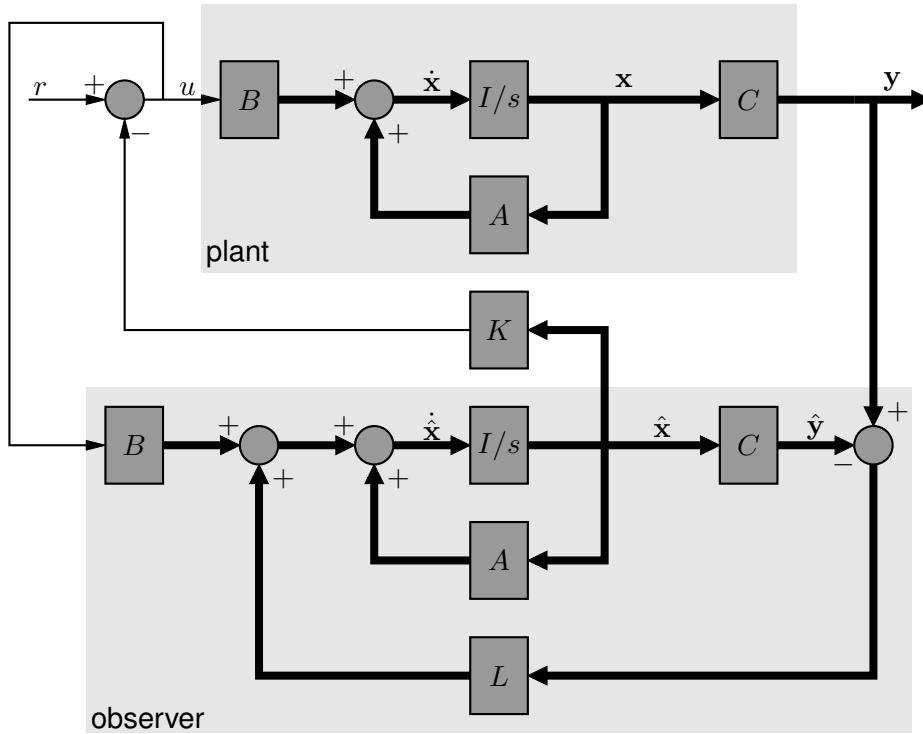
Figure 86: A further test of single-line diagram macros [EEP.m4].



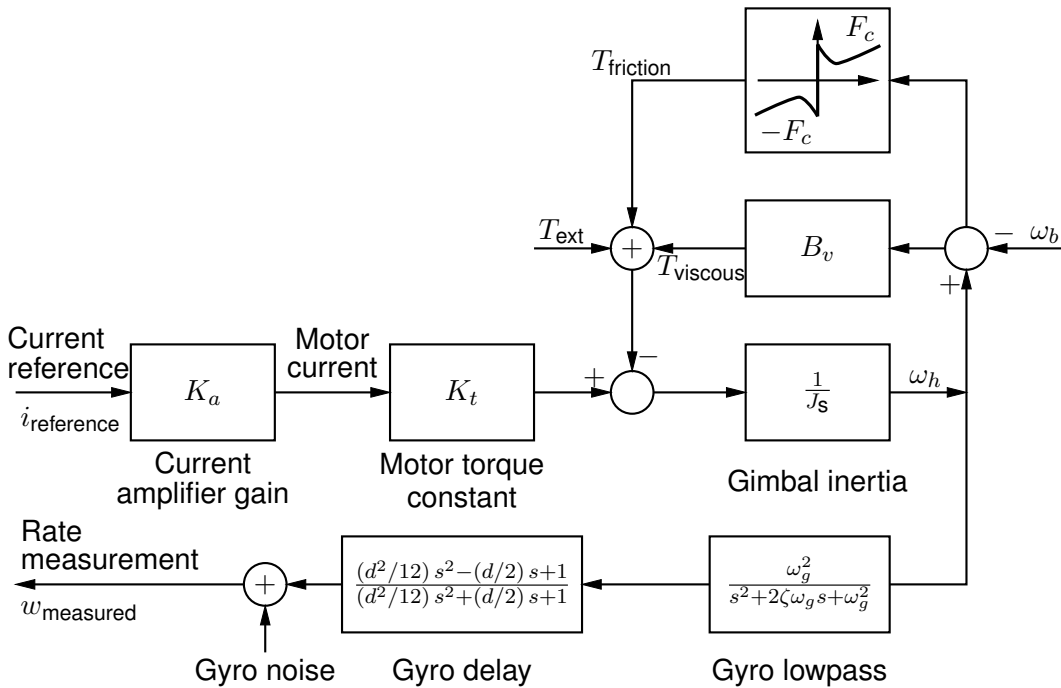
38



(a) *PID* control



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



(d) Single-axis gimbal model

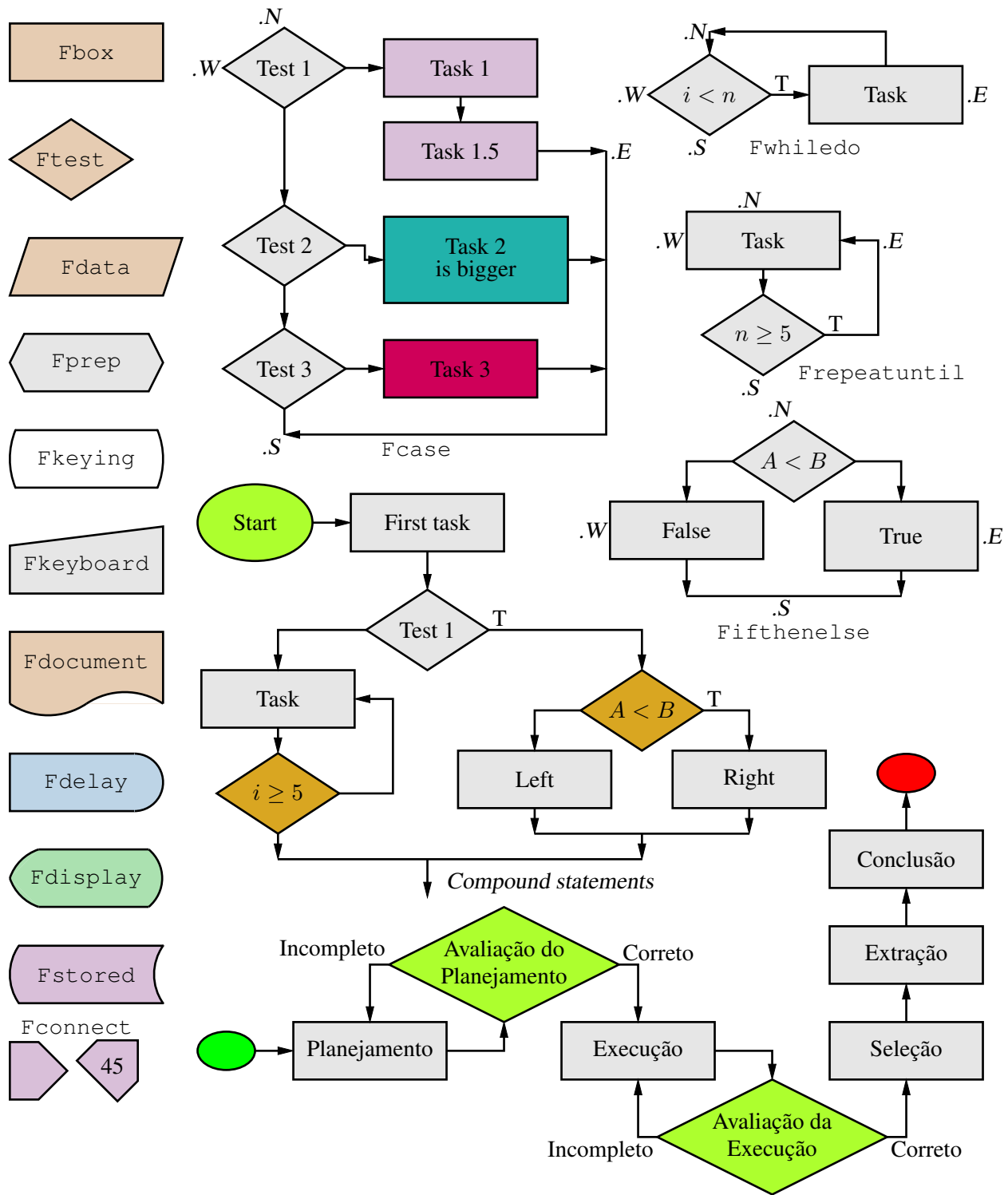


Figure 89: A flowchart sampler [Flow.m4].



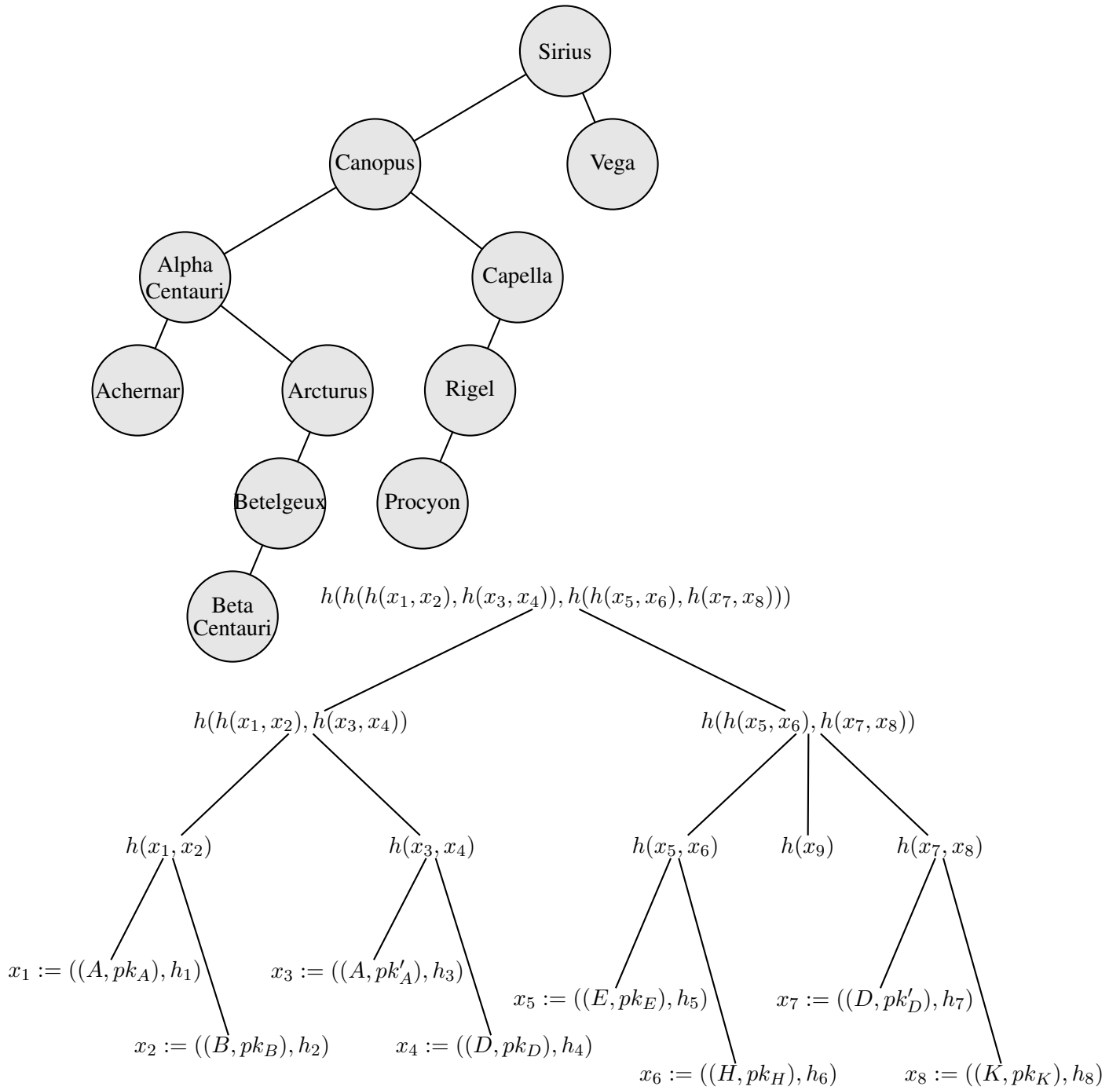


Figure 90: Trees [Btree.m4].

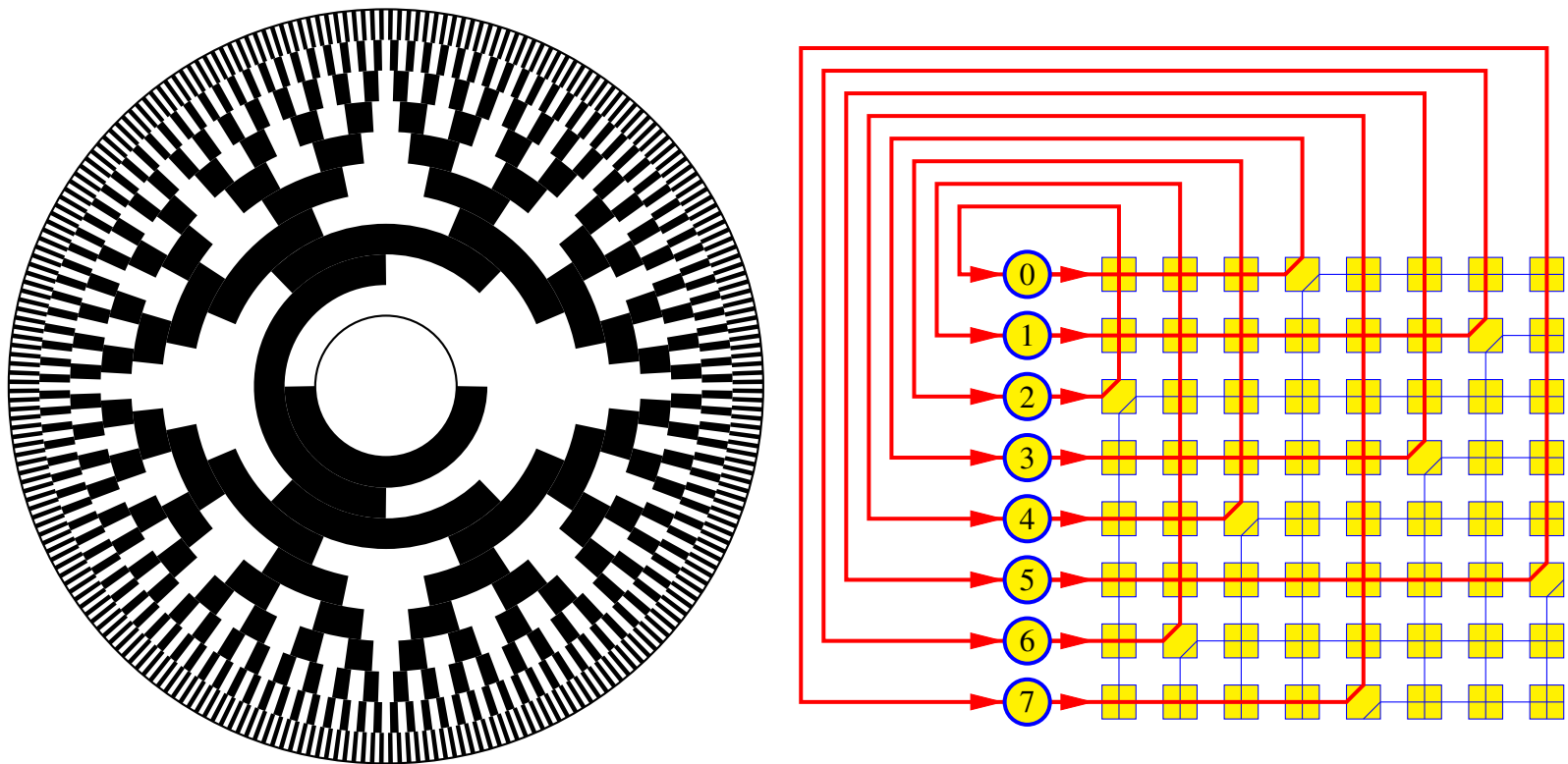


Figure 91: The power of looping and branching: Gray code 10-bit encoder disk pattern and a crossbar switch [GrayCode.m4].

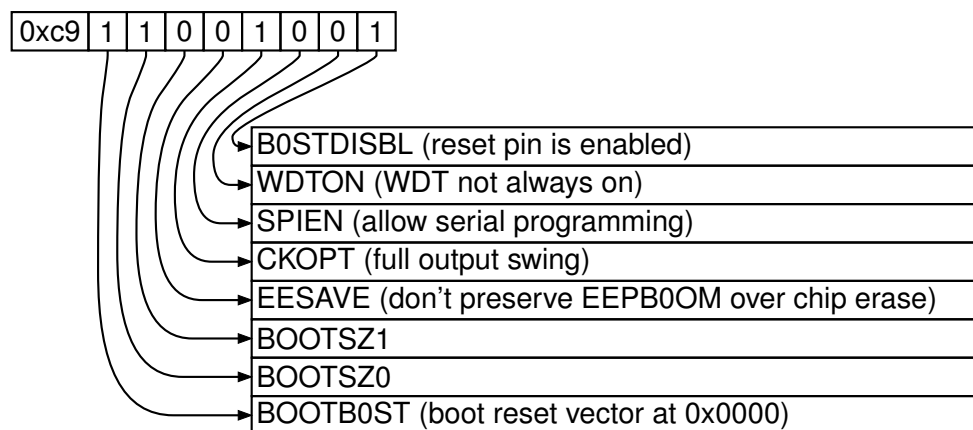


Figure 92: Elementary splines [Byte.m4].



Figure 93: A customizable seven-segment display showing the numbered segments, a custom shape, and the numerals from 0 to 9 [Sevensegment.m4].

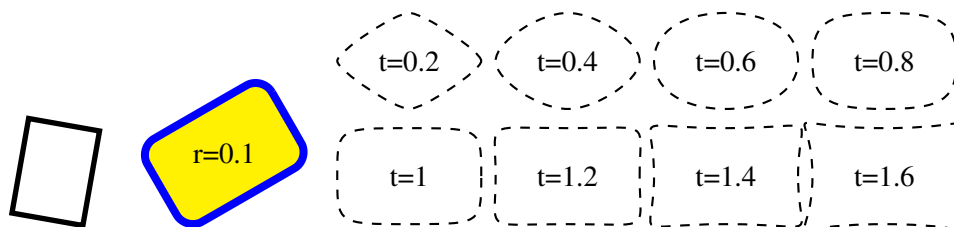


Figure 94: The macro `rotbox (wid,ht,type,[r|t=val])` draws a box in the current direction [Rotbox.m4].

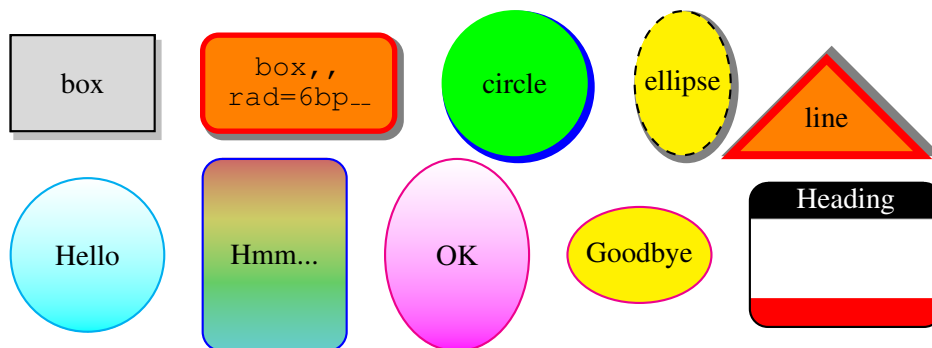


Figure 95: Embellishments: the top row illustrates `shadowed(box|circle|ellipse|line,[at position],keys)` and the second row `ColoredV(box|circle|ellipse,(r,g,b)|((colorseq)),attributes)` [Shadowed.m4].

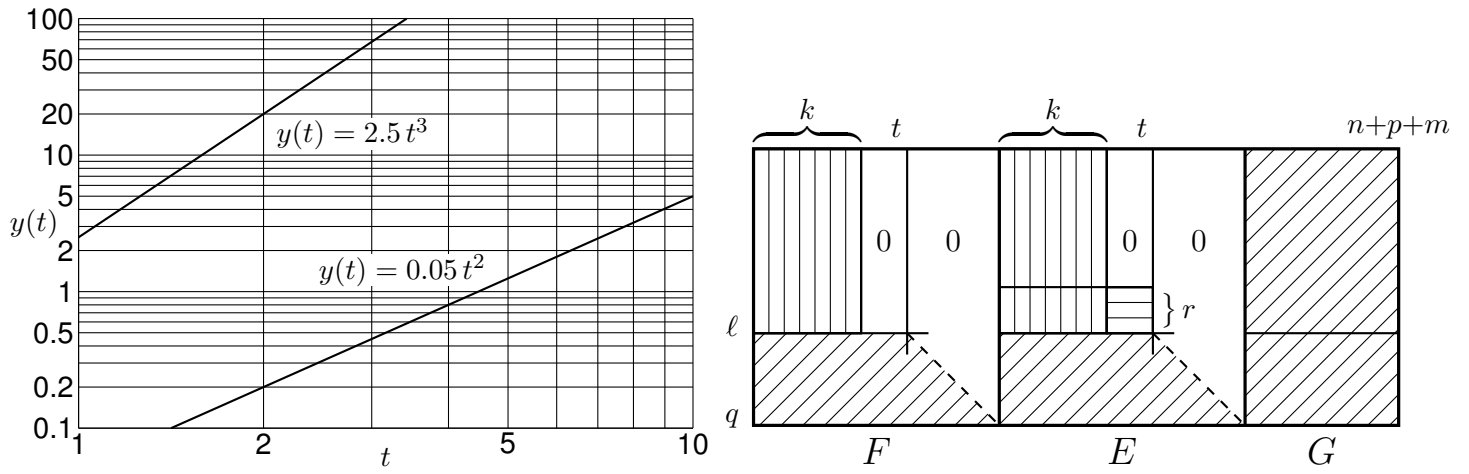


Figure 96: A graph and crosshatching example drawn using the pic language [Loglog.m4].

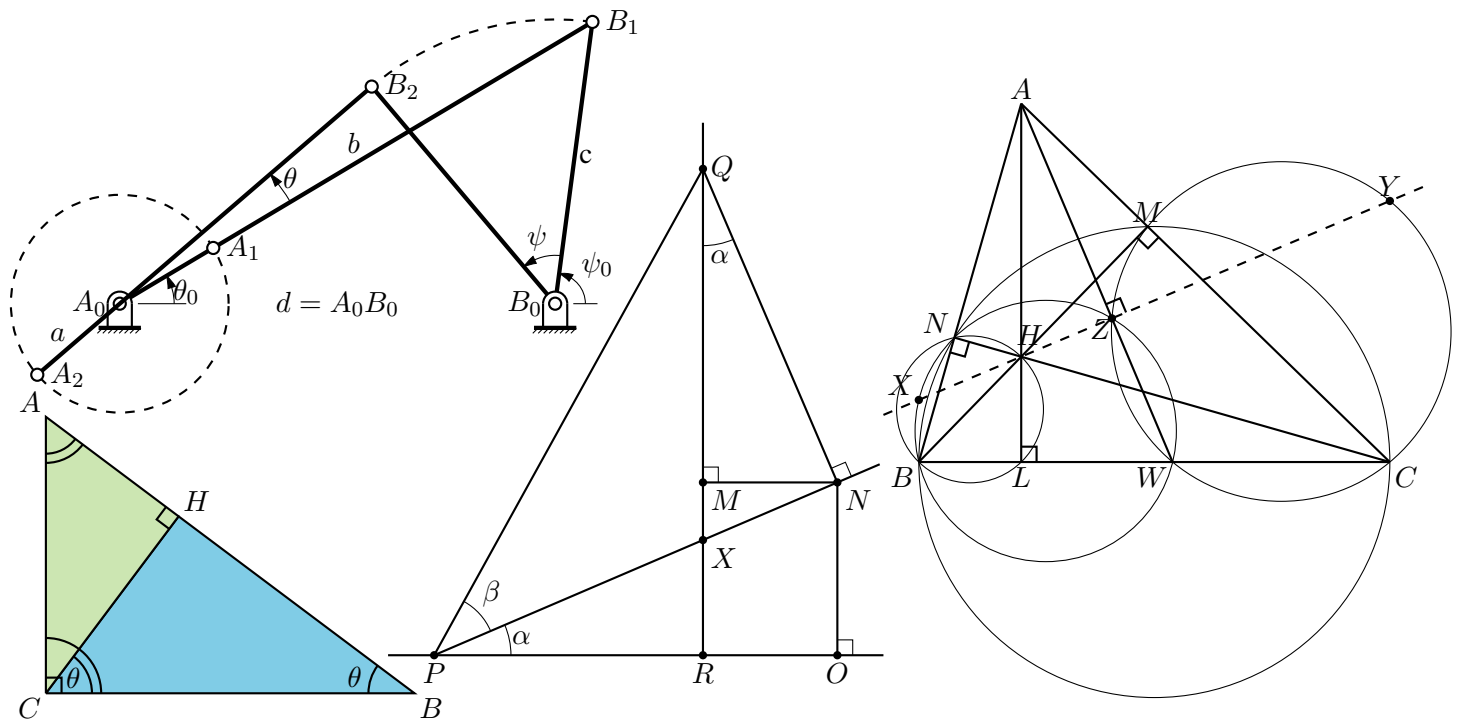


Figure 97: Some geometrical constructions [Geometry.m4].

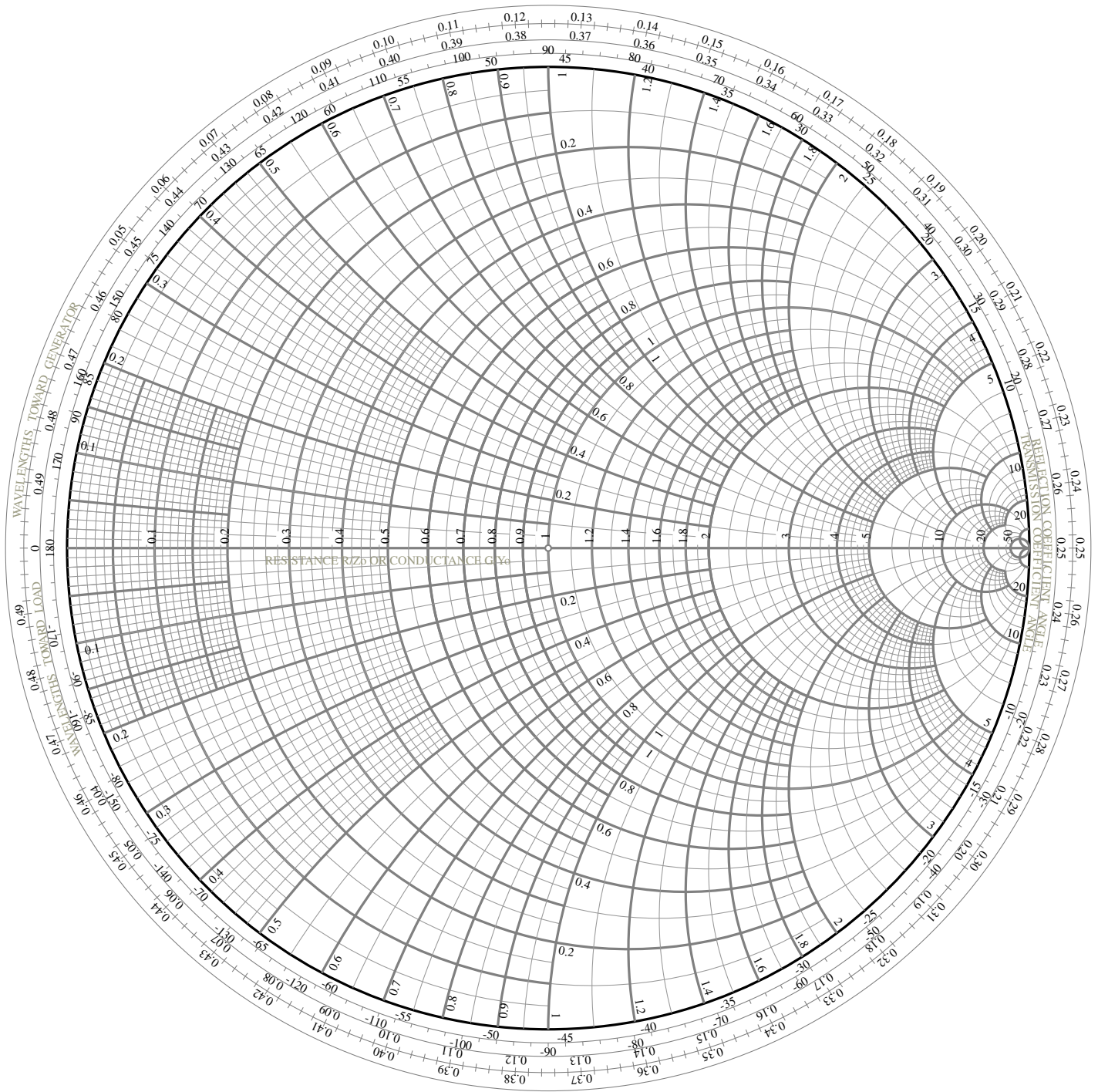
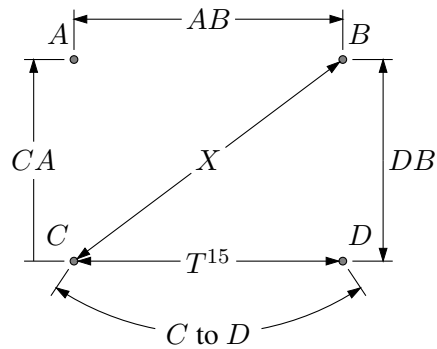
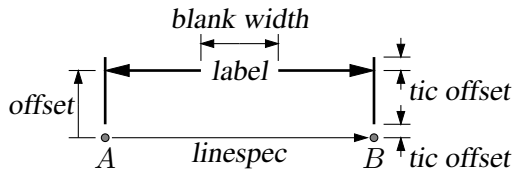
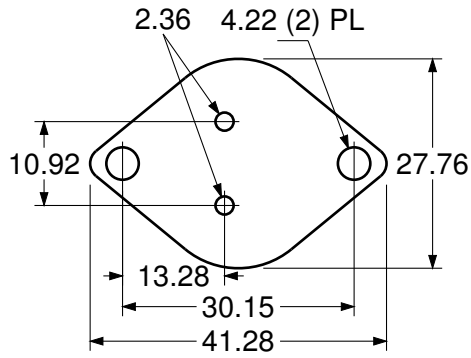


Figure 98: A Smith chart [Smithlchart.m4].



```

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 99: 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].

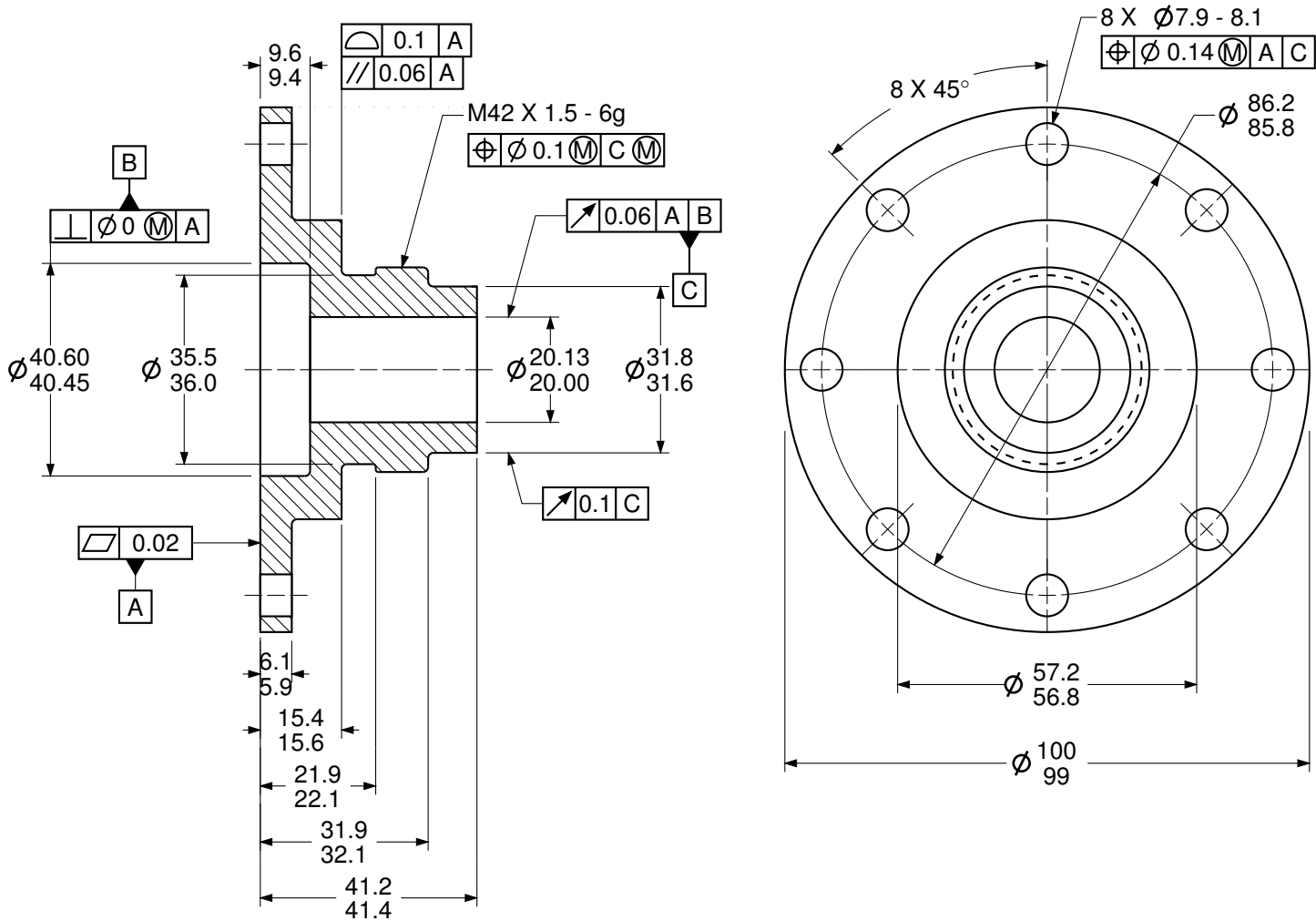


Figure 100: Dimensioning with tolerances [Plate.m4].

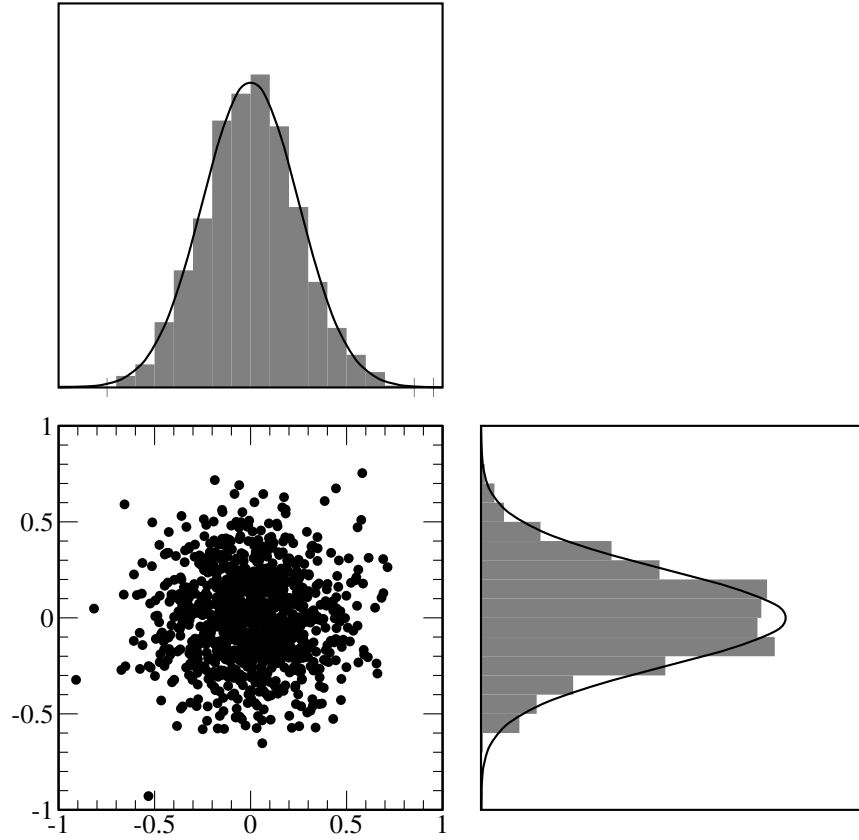


Figure 101: Testing random number generation using dpic macro `randn (array name, n, mean, std dev)` which calls pic built-in `rand()` [random.m4].

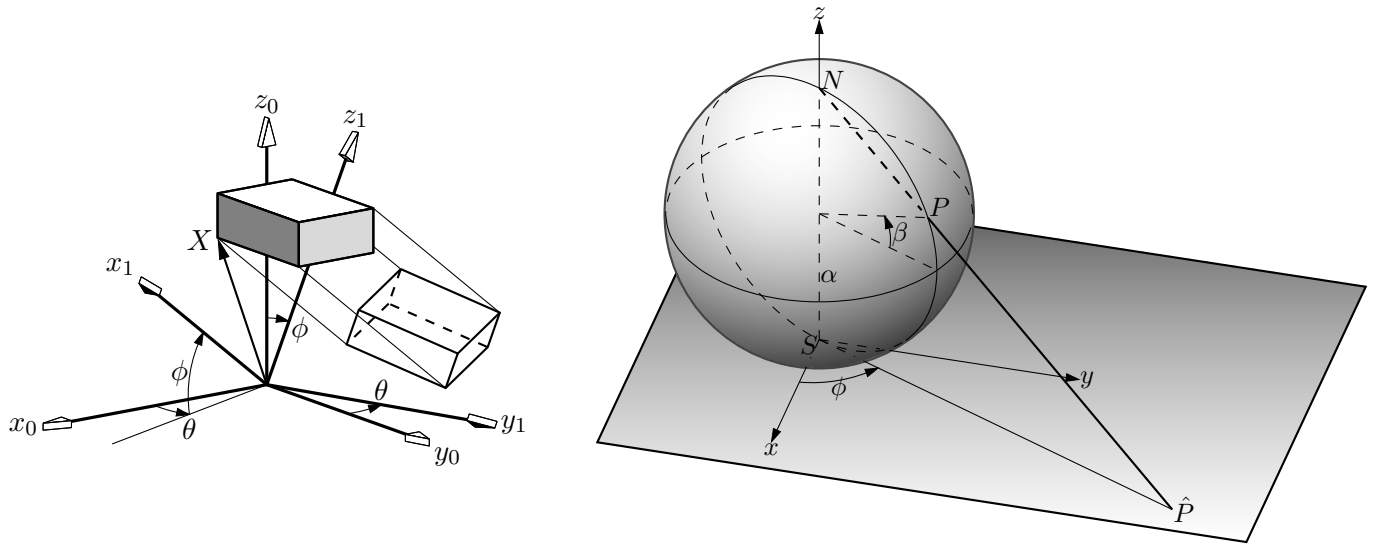


Figure 102: Test of `project` and other lib3D macros, showing the projection of a solid onto the  $y_1, z_1$  plane by sighting along the  $x_1$  axis. [exp.m4].



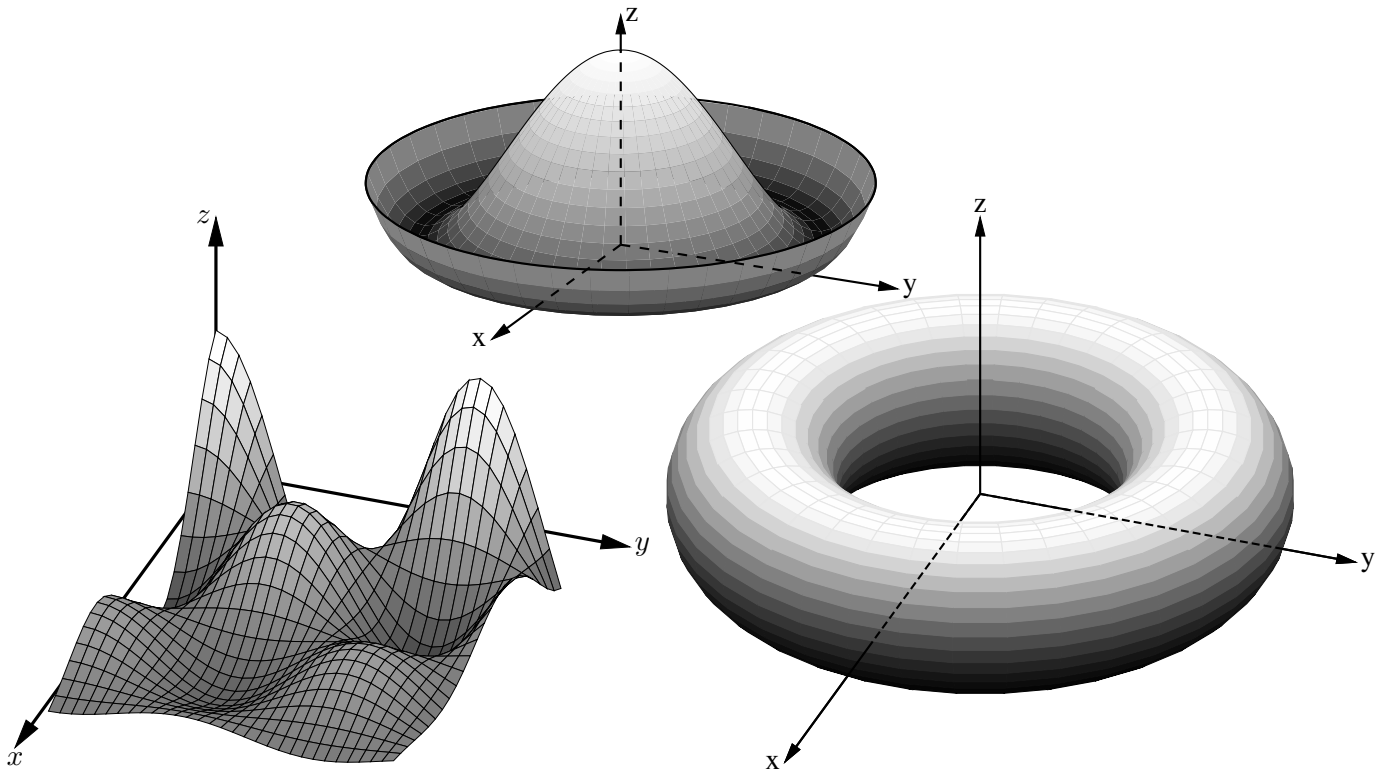


Figure 103: Plotting surfaces using gray scales [graysurf.m4].

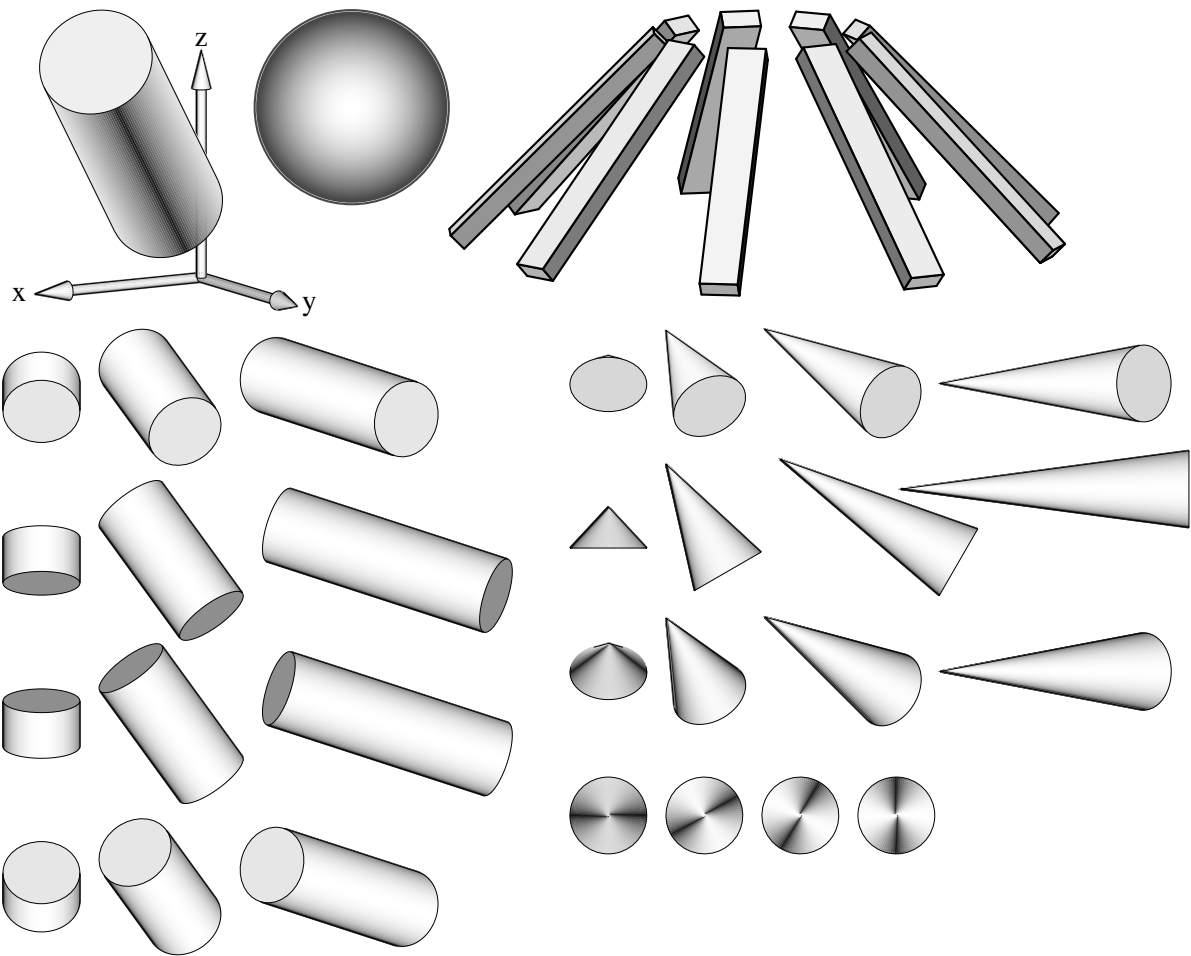


Figure 104: Basic shapes [shapes.m4].

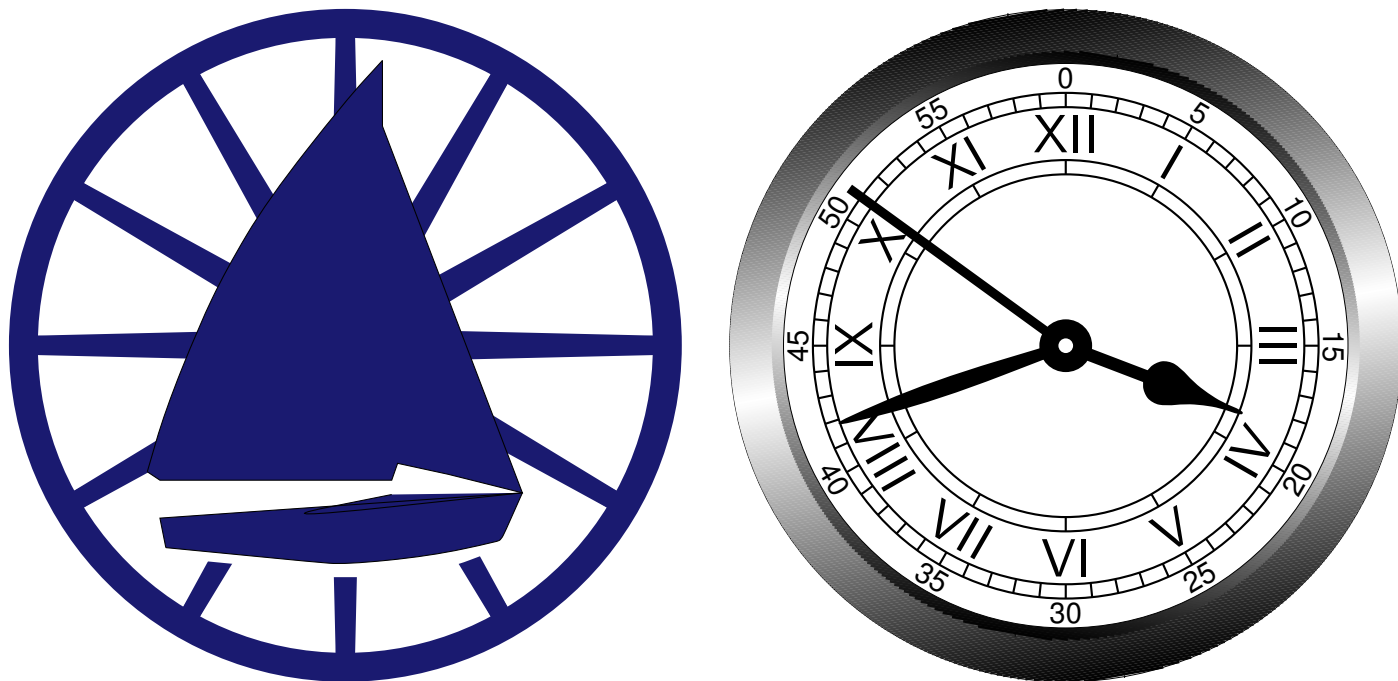


Figure 105: Conestoga Sailing Club (illustrating the filling of arbitrary shapes) and an antique clock face with shading and rotated text [csc.m4].

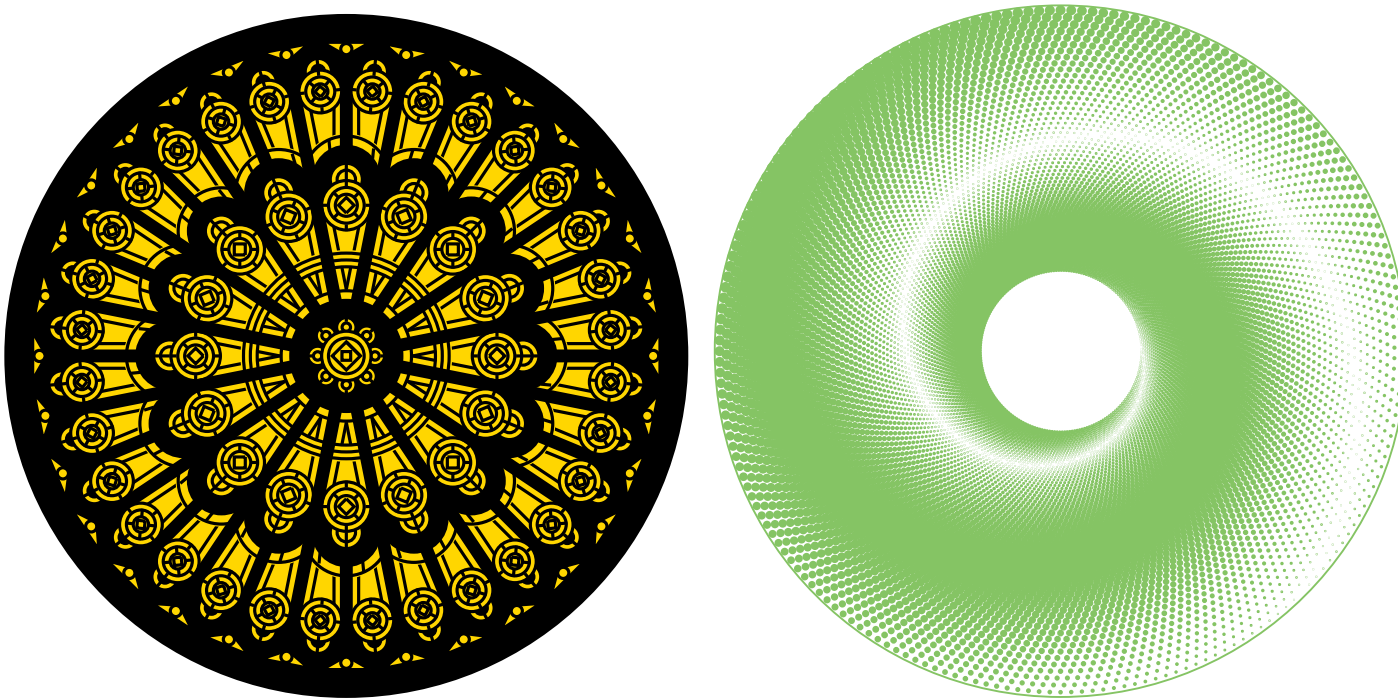


Figure 106: The left object, used for testing `dipic`, is redrawn from a detail of the set design for the musical *Dracula*. This consumes much  $\text{\LaTeX}$  main memory but can be produced directly as pdf using `dpic -d`, as svg using `dpic -v`, or as postscript using `dpic -r` since no text formatting is required. The right object adjusts the size of dots to produce a halftone effect [rose.m4].

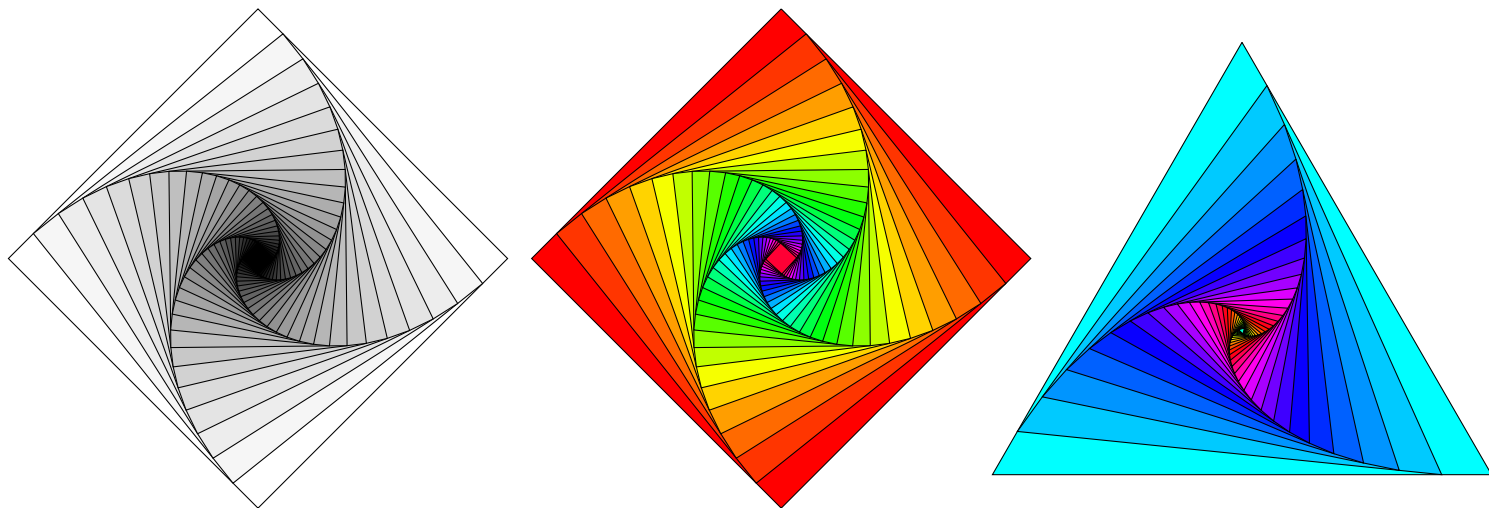


Figure 107: Variations on M. Goossens, S. Rahtz, and F. Mittelbach, *The L<sup>A</sup>T<sub>E</sub>X Graphics Companion*, Addison-Wesley 1997, pp. 57-58 [diamond.m4].

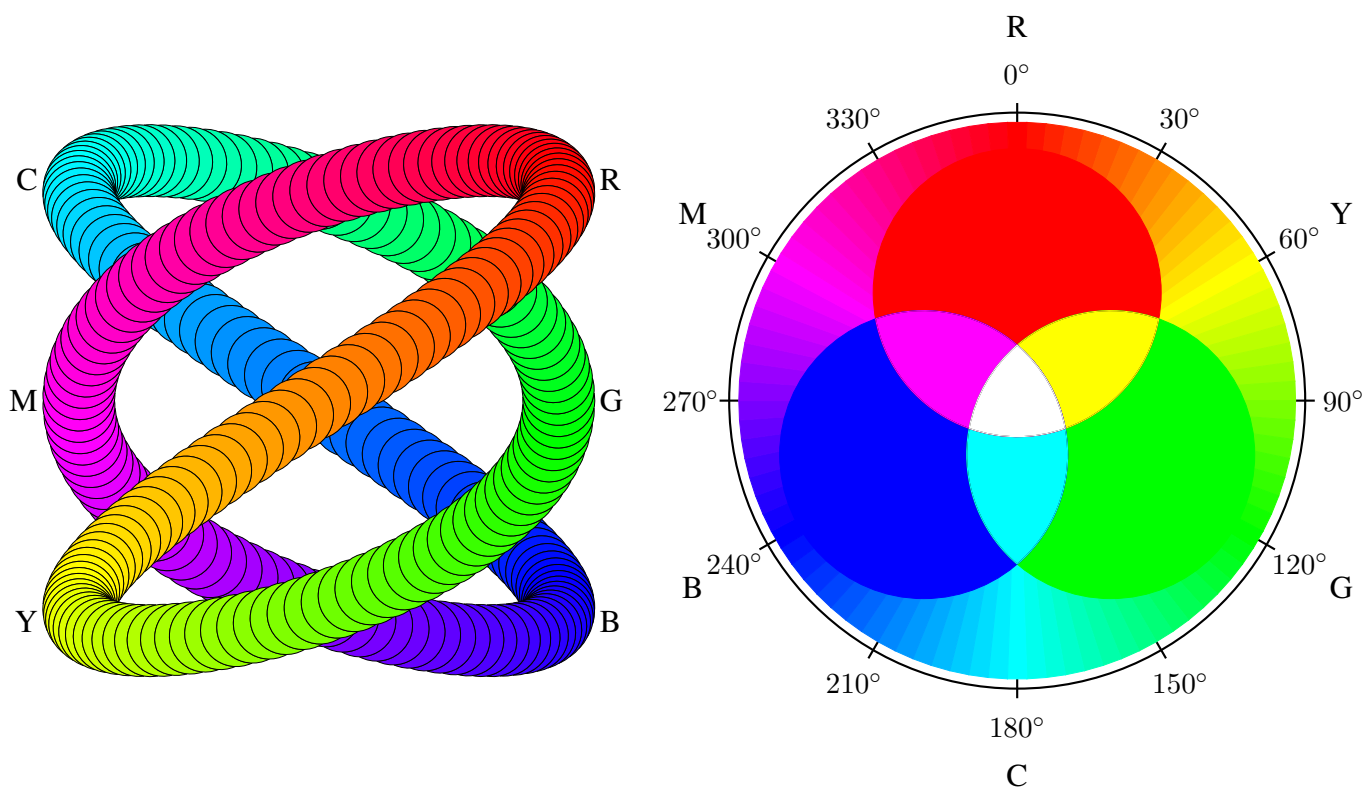


Figure 108: An exercise in calculating RGB colours [worm.m4].

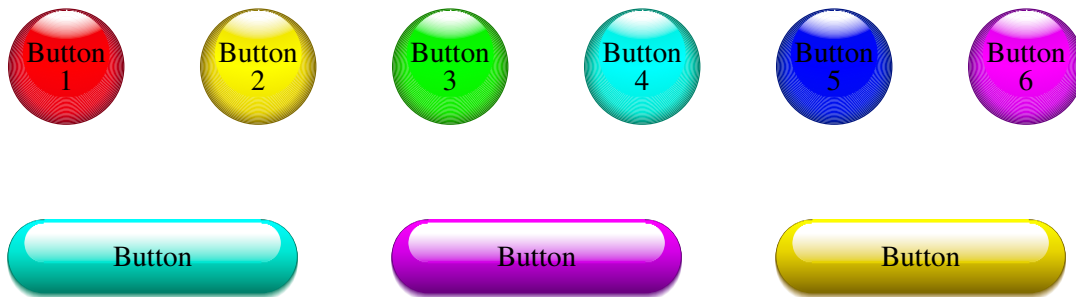


Figure 109: Shading in color [Buttons.m4].



Figure 110: This diagram has been produced as svg with `dpic -v` (then converted to pdf for inclusion in examples.pdf) [keyboard.m4].

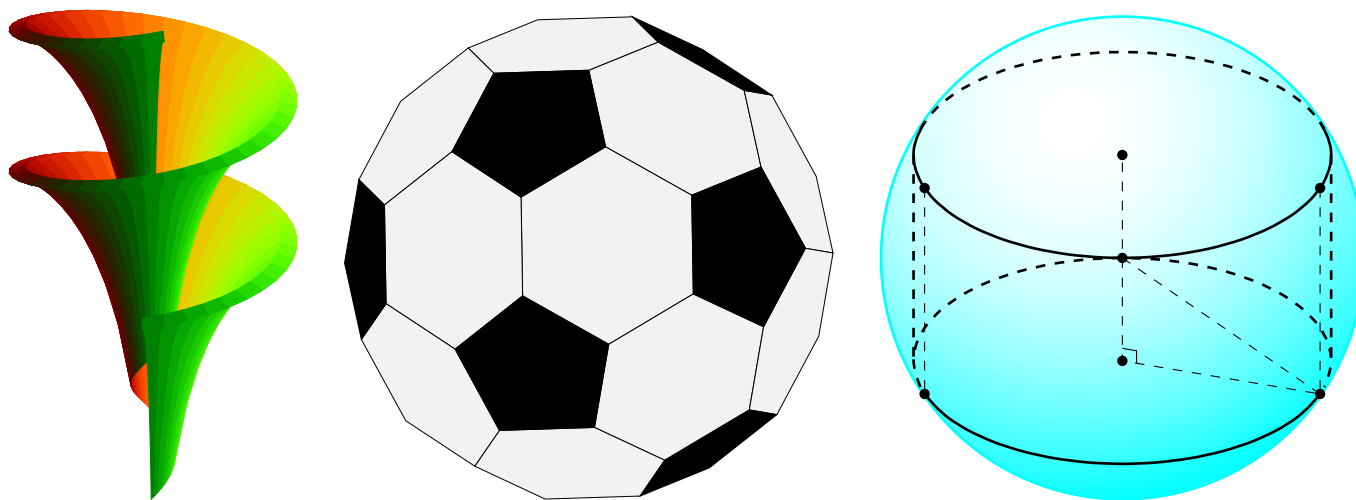


Figure 111: Dini surface, an icosahedron, and a sphere with inscribed cylinder [Dini.m4].

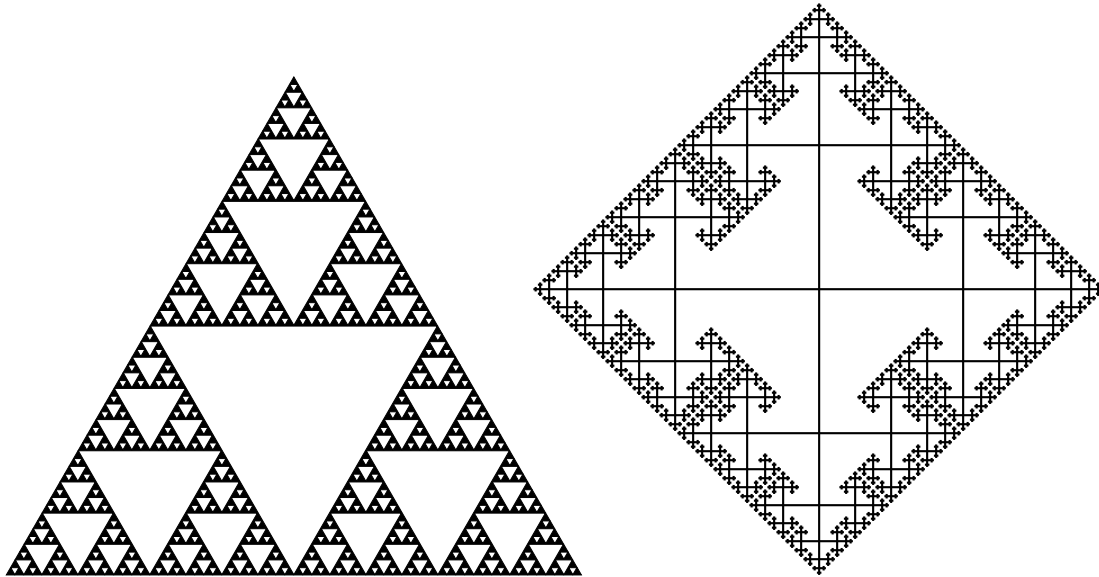


Figure 112: The Sierpinski triangle and a Cayley graph: tests of pic macro recursion [Sierpinski.m4].

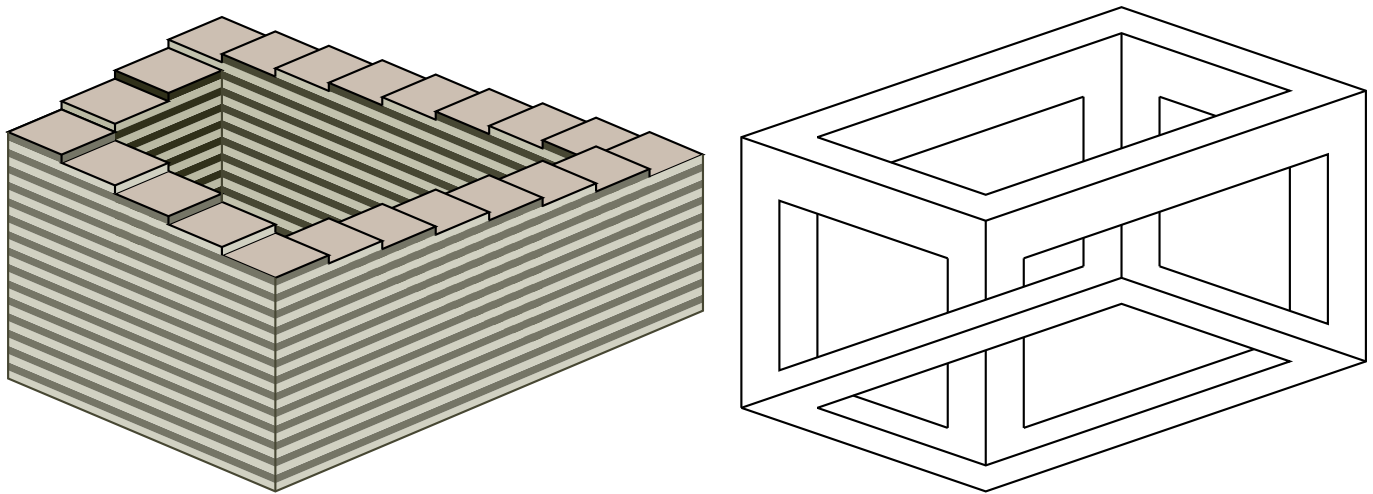


Figure 113: Penrose stairs and an Escher-like object [Escher.m4].

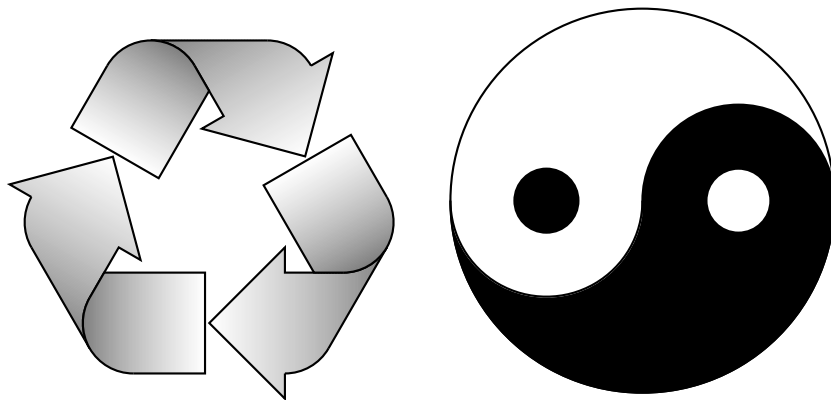


Figure 114: Modest repetition and partial fill [recycle.m4].

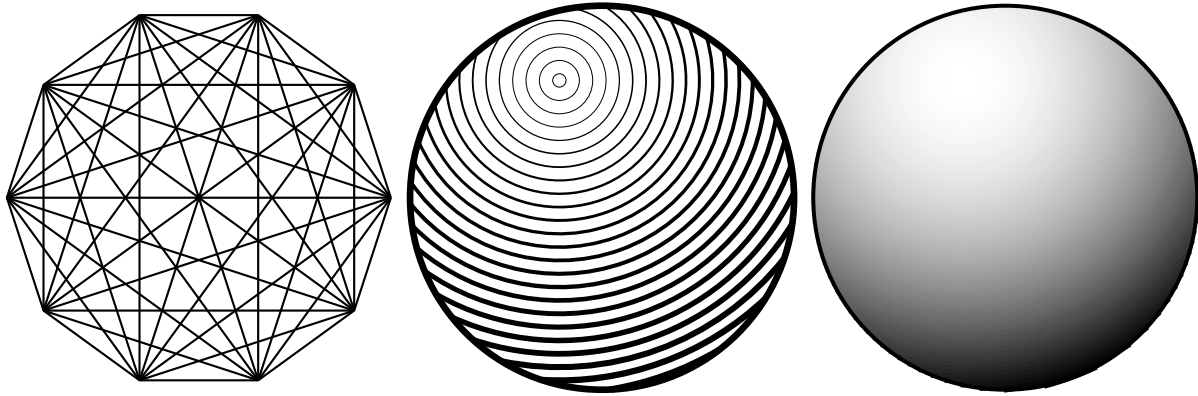


Figure 115: Simple diagrams that are easily drawn by looping [ex15.m4].

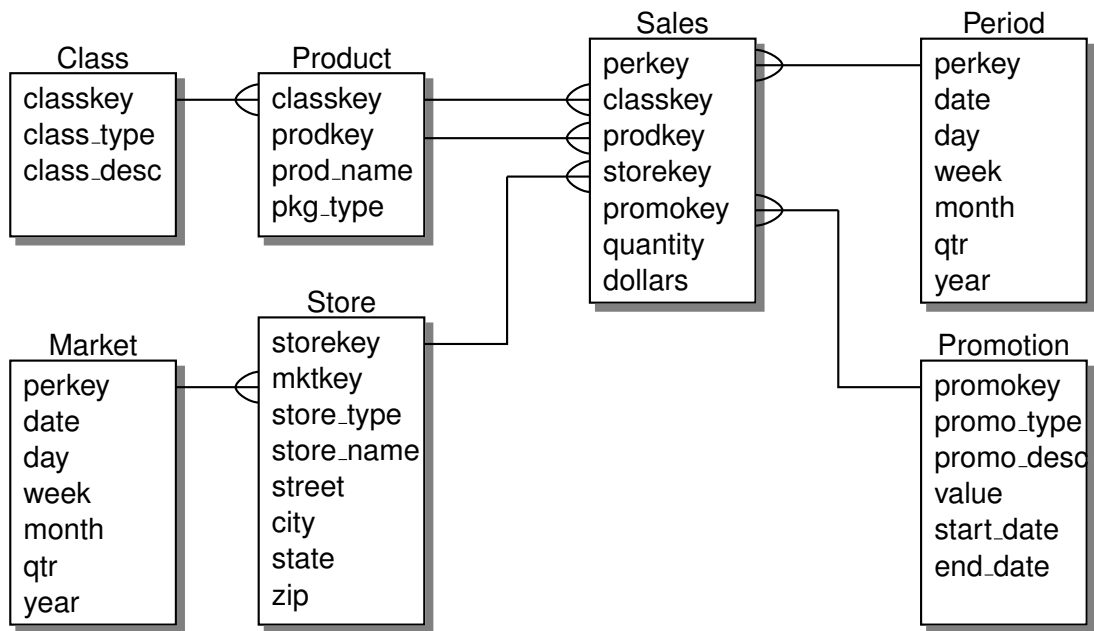


Figure 116: Illustrating shadebox and a custom crowfoot line termination [Crow.m4].



Figure 117: Overlaying a figure with line graphics [Incleps.m4].