Examples: Version 10.6

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.

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.

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

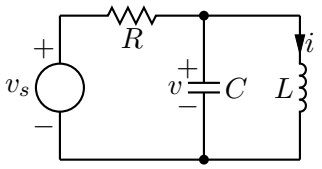


Figure 1: The quick-start example from the manual [quick.m4].

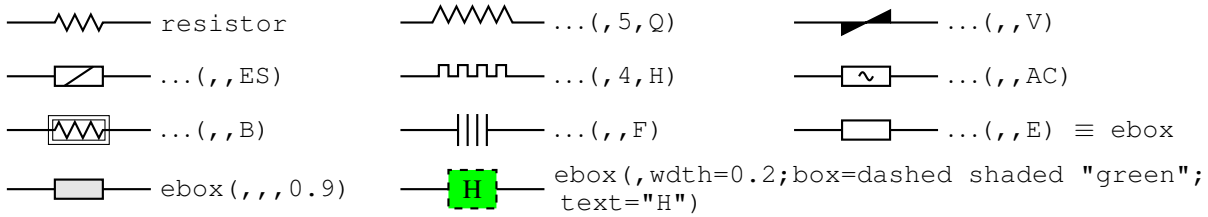


Figure 2: Resistors, showing some variations and the ebox [Resistors.m4].

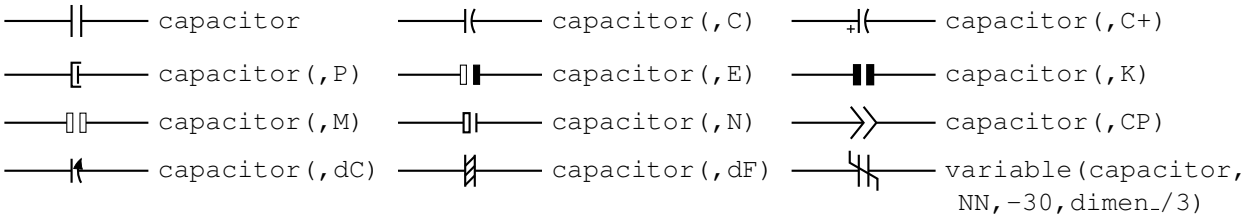


Figure 3: Capacitors [Capacitors.m4].

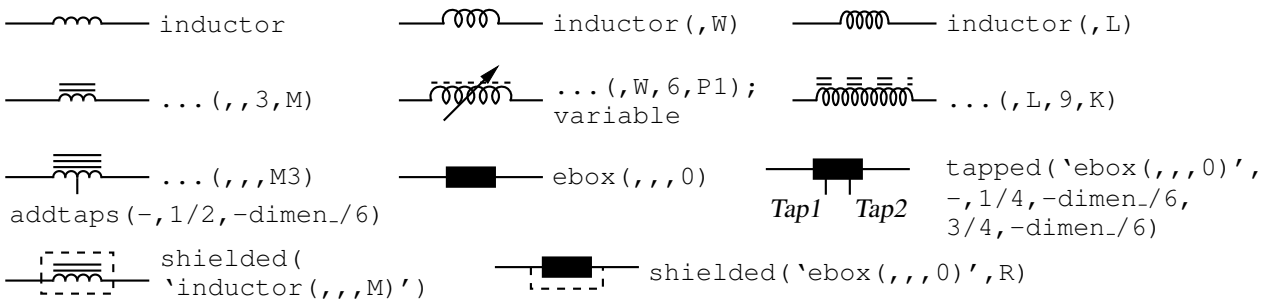


Figure 4: Inductors `[Inductors.m4]`.

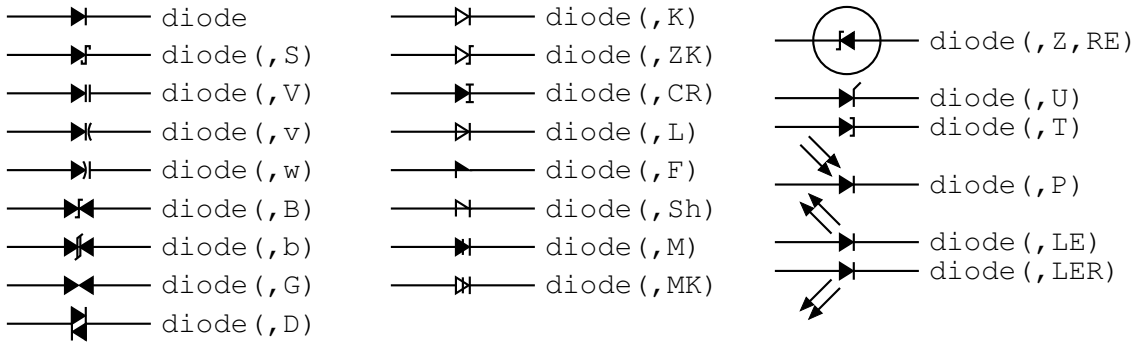


Figure 5: Diodes: appending a `K` to the second argument draws an open arrowhead `[Diodes.m4]`.

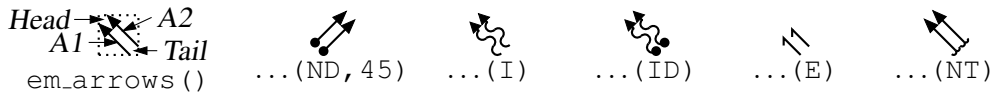


Figure 6: Radiation arrows `[Emarrows.m4]`.

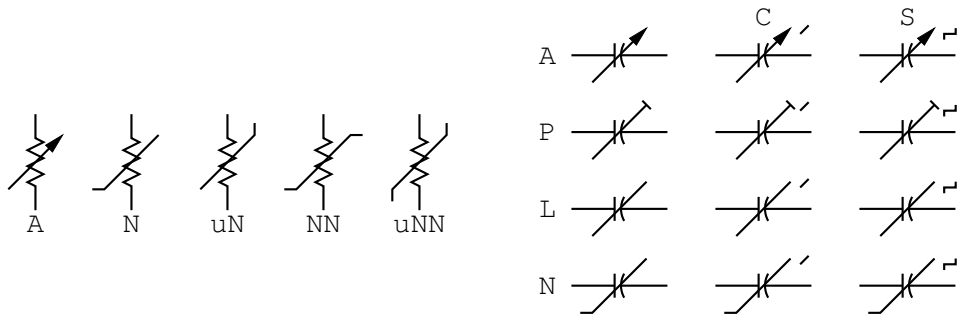


Figure 7: Arrows and marks for showing variability `[Variable.m4]`.

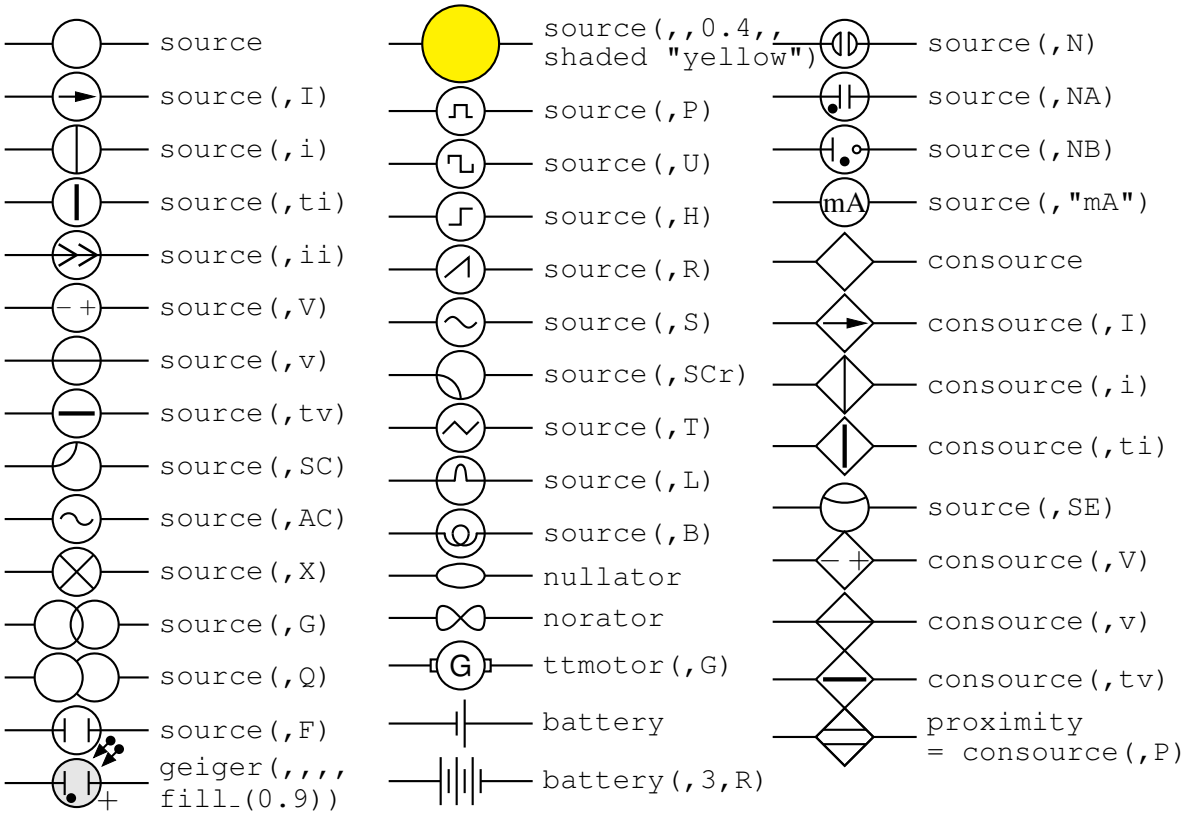


Figure 8: Sources and source-like elements `[Sources.m4]`.

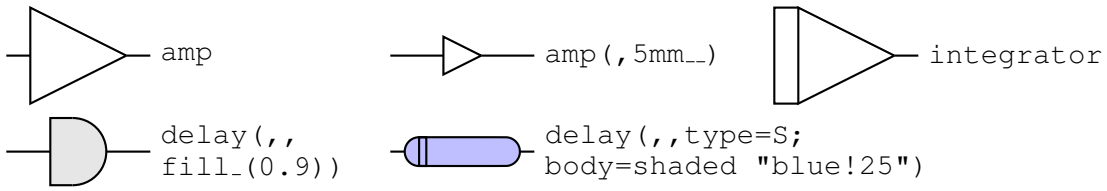


Figure 9: Macros `amp`, `delay`, and `integrator` `[AmpTable.m4]`.

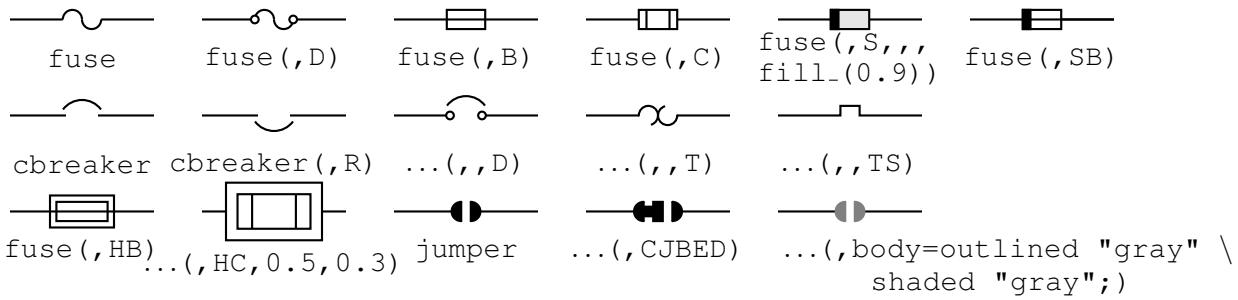


Figure 10: Macros `fuse`, `cbreaker`, and `jumper` `[Fuses.m4]`.

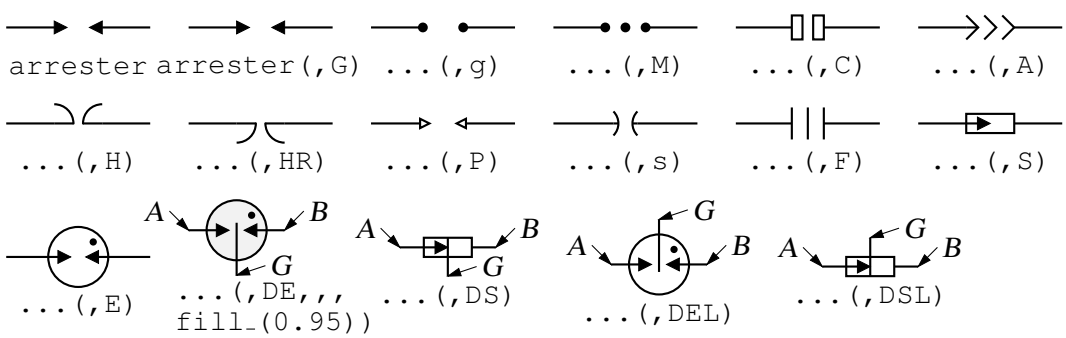


Figure 11: The `arrester` macro `[Arresters.m4]`.

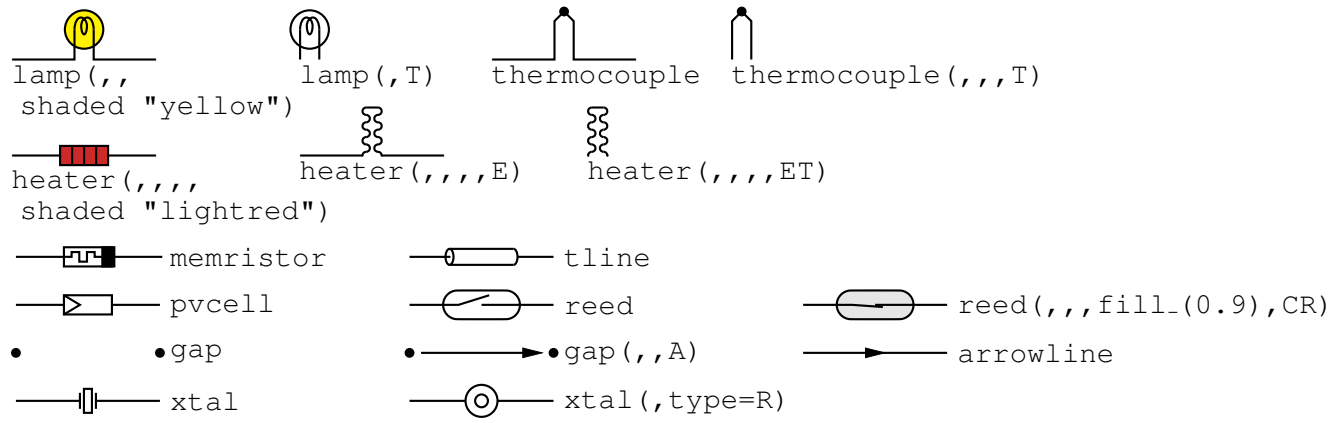


Figure 12: Additional two-terminal elements `[MoreTable.m4]`.

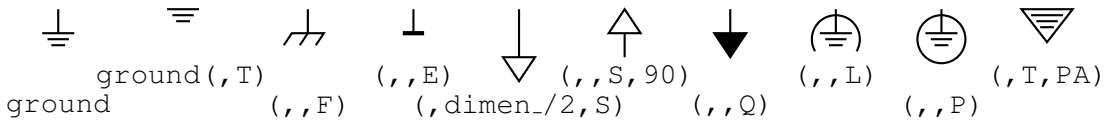


Figure 13: Ground symbols `[Grounds.m4]`.

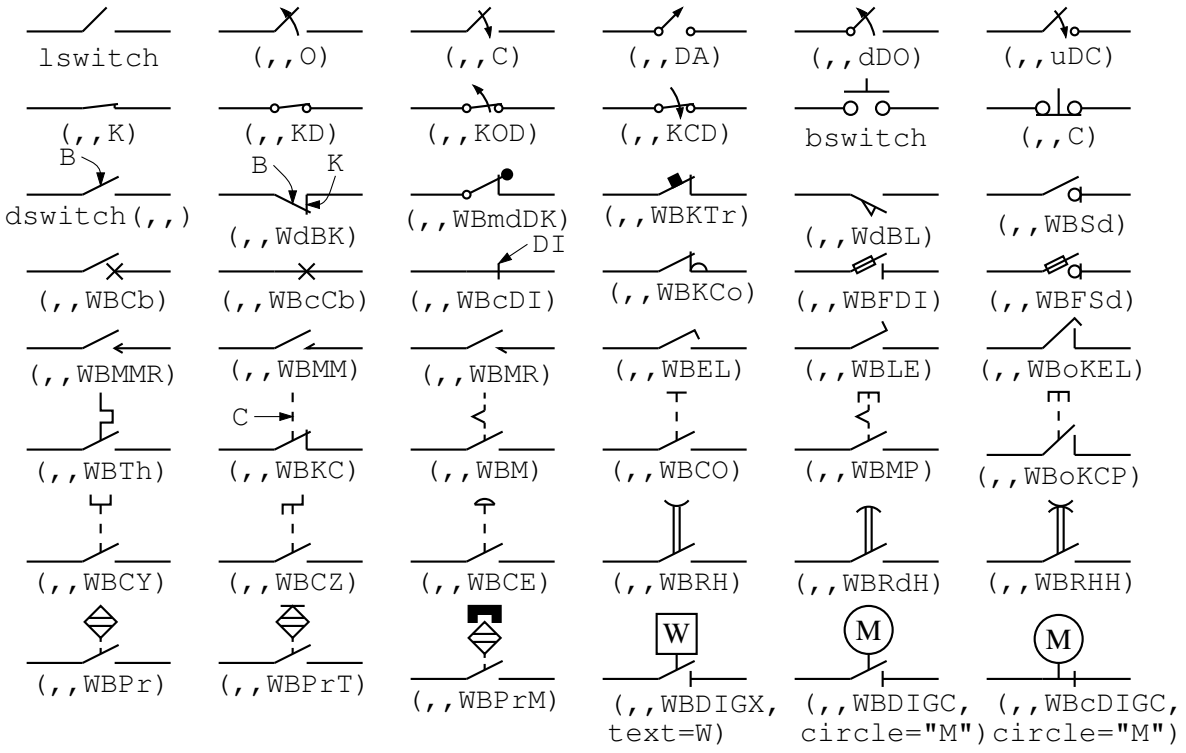


Figure 14: The switch macros; `switch(,,,L|B|D)` is a wrapper for `lswitch`, `bswitch`, and `dswitch` `[Switches.m4]`.

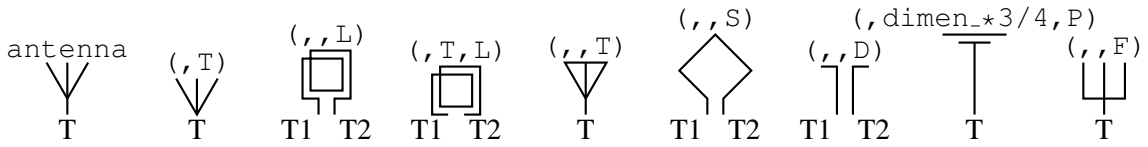


Figure 15: Antenna symbols `[Antennas.m4]`.

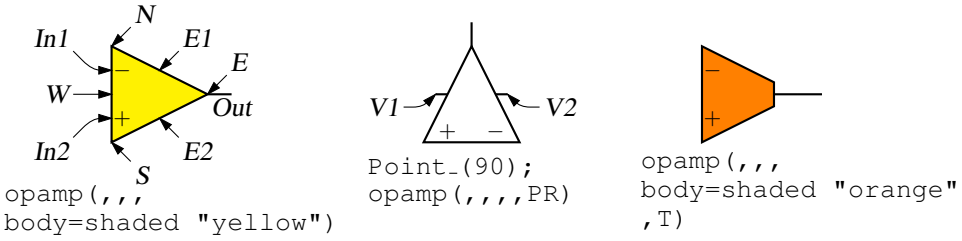


Figure 16: The opamp `[Opamp.m4]`.

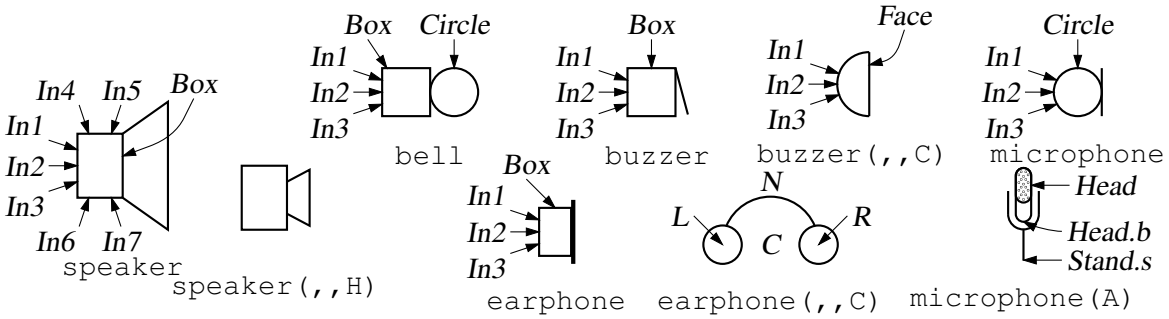


Figure 17: Audio elements `[Audio.m4]`.

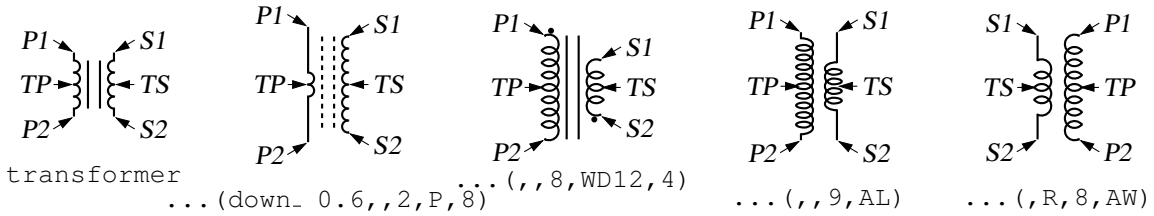


Figure 18: Some variations of the transformer element, drawing direction down `[Xform.m4]`.

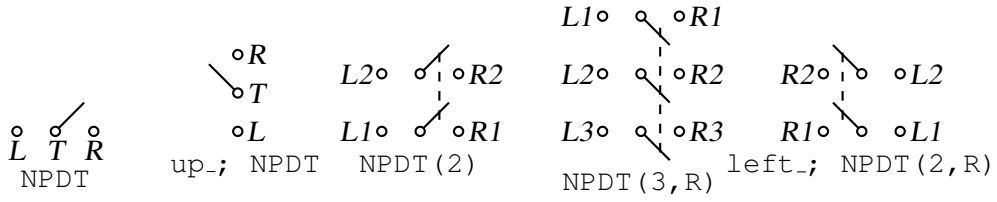


Figure 19: Double throw with the `NPDT` macro `[NPDT.m4]`.

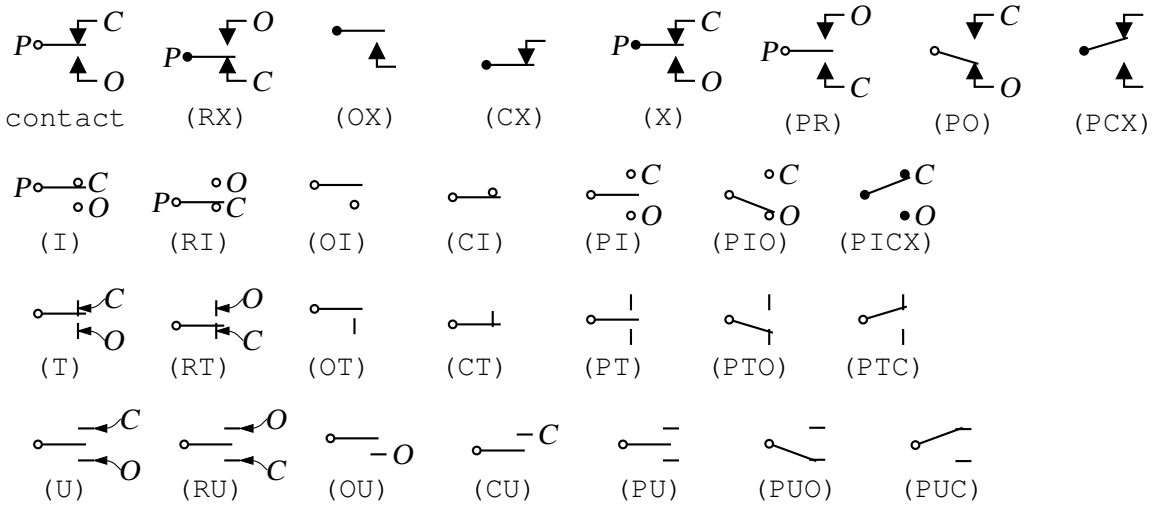


Figure 20: A non-exhaustive sampling of `contact` macro variations `[Contact.m4]`.

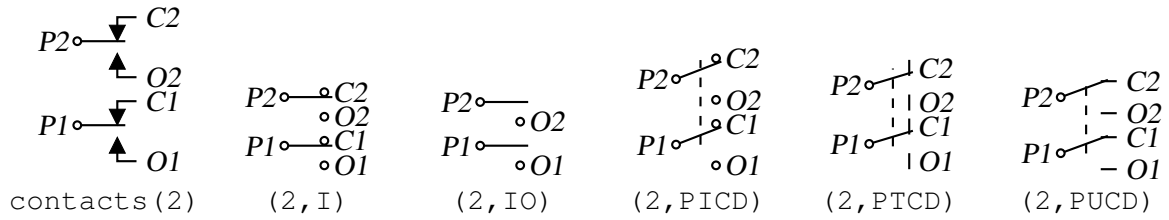


Figure 21: The `contacts` macro `[Contacts.m4]`.

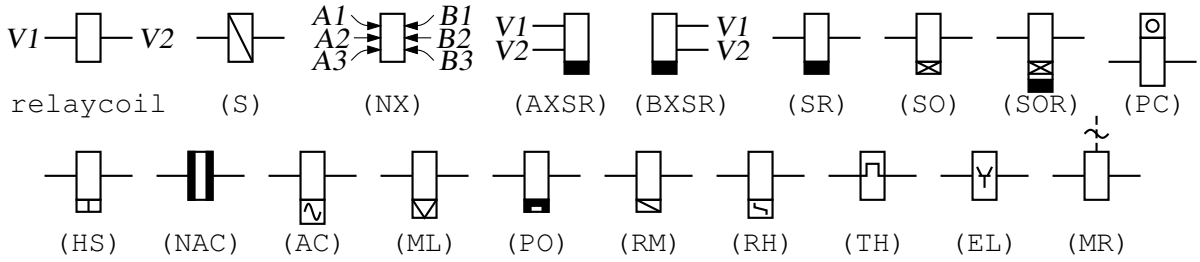


Figure 22: The `relaycoil` macro `[relaycoil.m4]`.

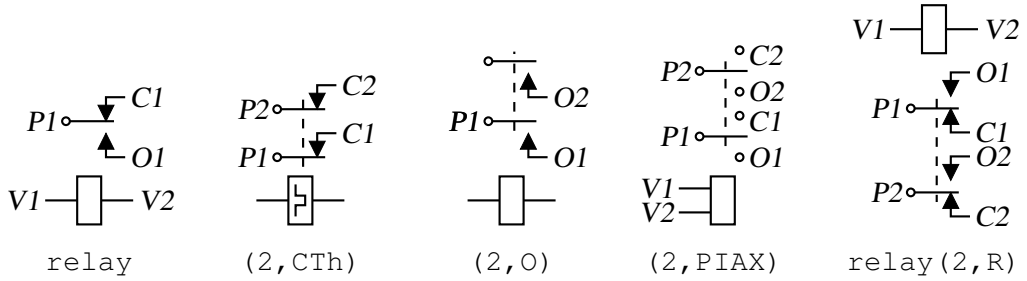


Figure 23: Some variants of `relay` `[Relay.m4]`.

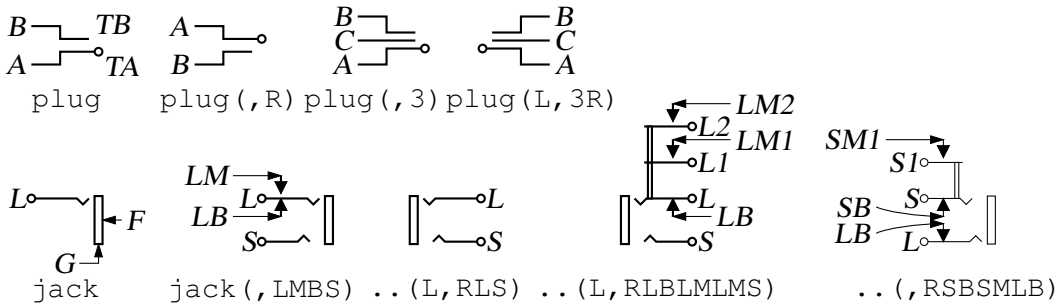


Figure 24: The `jack` and `plug` macros `[Jack.m4]`.

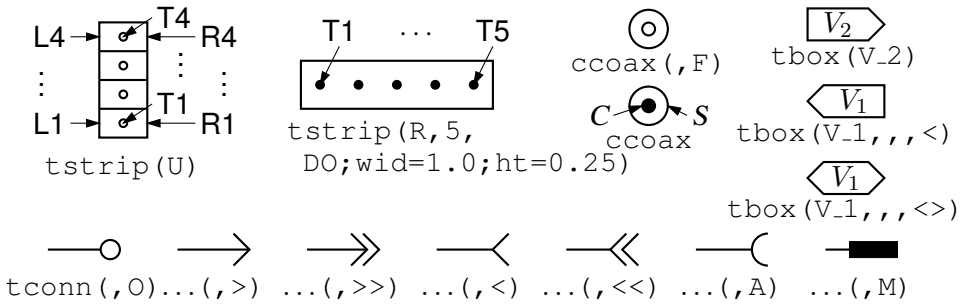


Figure 25: The `tstrip`, `ccoax`, `tconn`, and `tbox` macros `[Conn.m4]`.

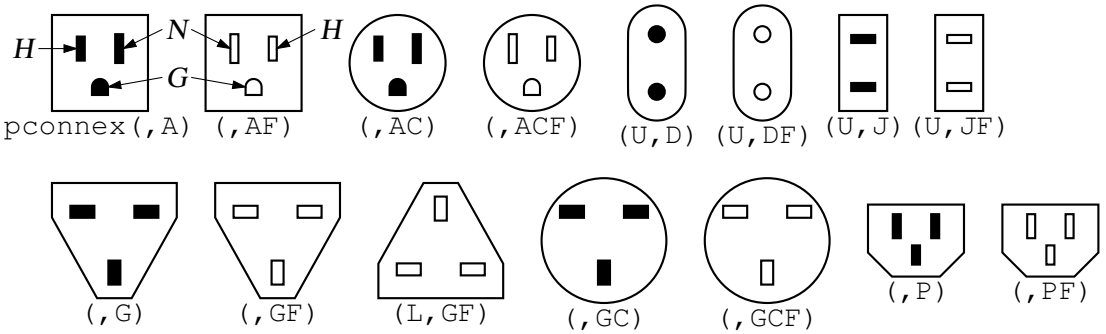


Figure 26: The `pconnex` macro `[Pconn.m4]`.

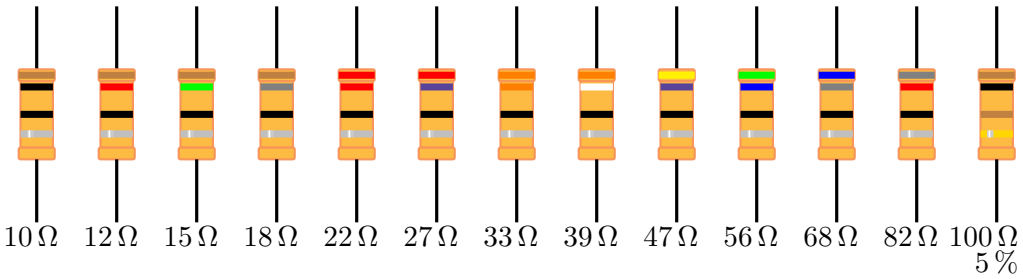


Figure 27: Color-coded through-hole resistors. All are 10 percent tolerance except for the last, which illustrates 5 percent `[cbresistor.m4]`.

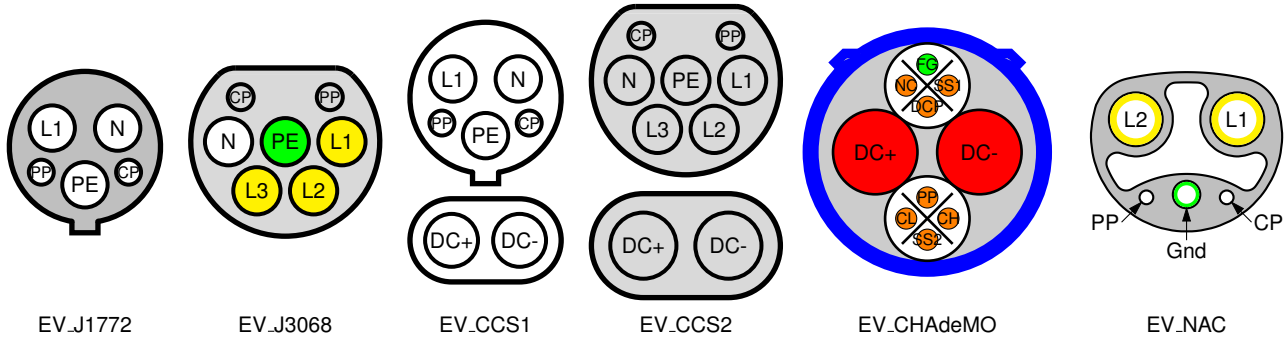


Figure 28: Electric vehicle charging plug patterns make extensive use of *key=value* pairs to set options `[EVplugs.m4]`.

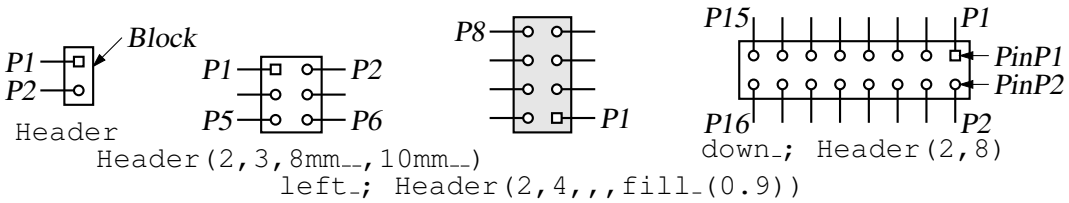


Figure 29: The `Header` macro `[Headers.m4]`.

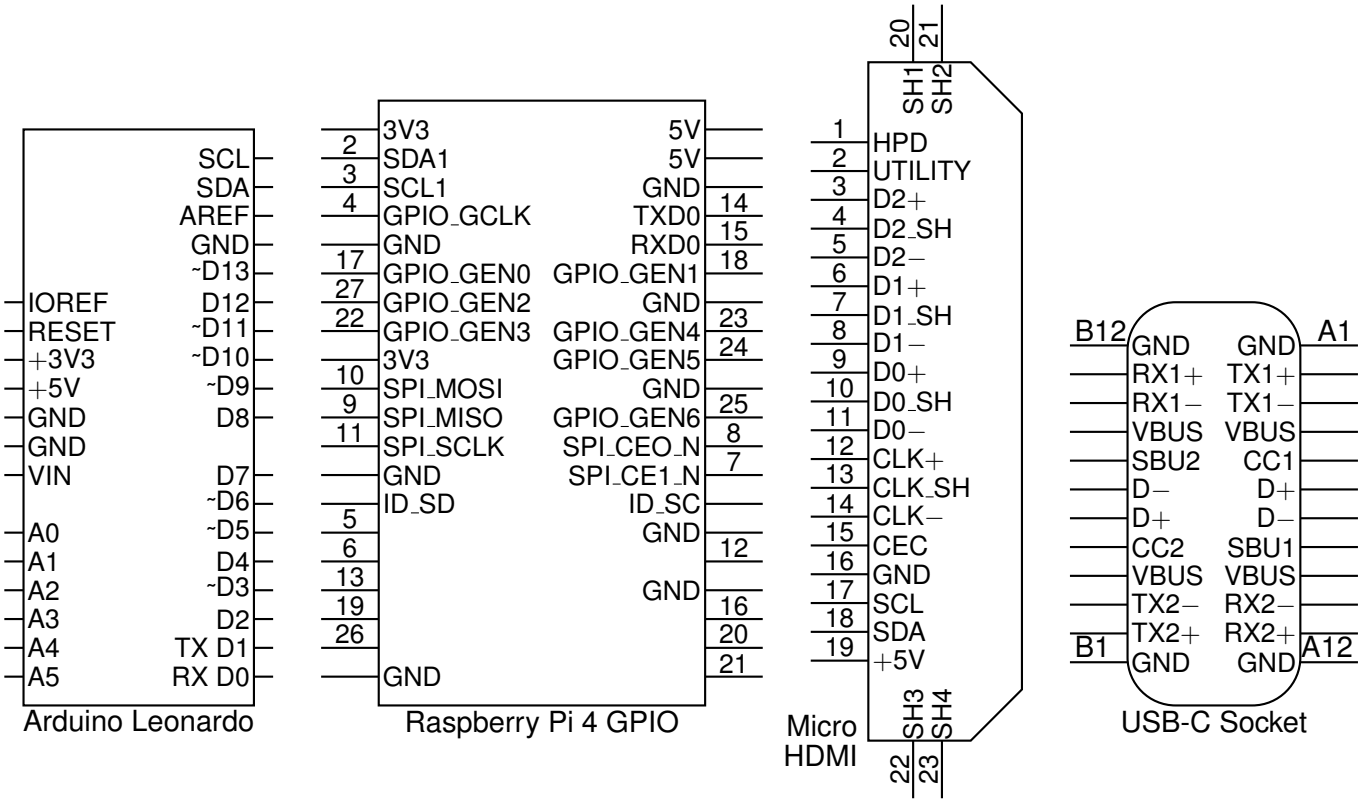


Figure 30: Some connectors with simple geometry and lists of labels `[Connectors.m4]`.

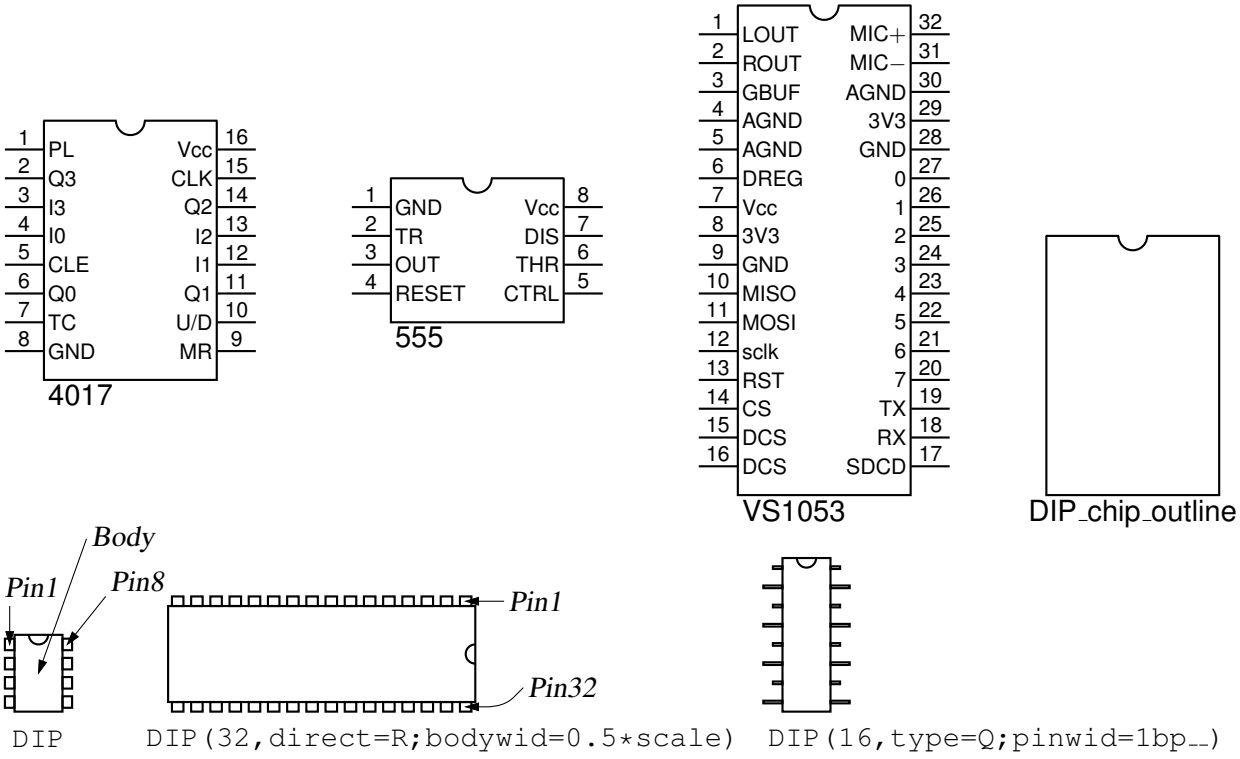


Figure 31: IC package outlines and examples [Chips.m4].

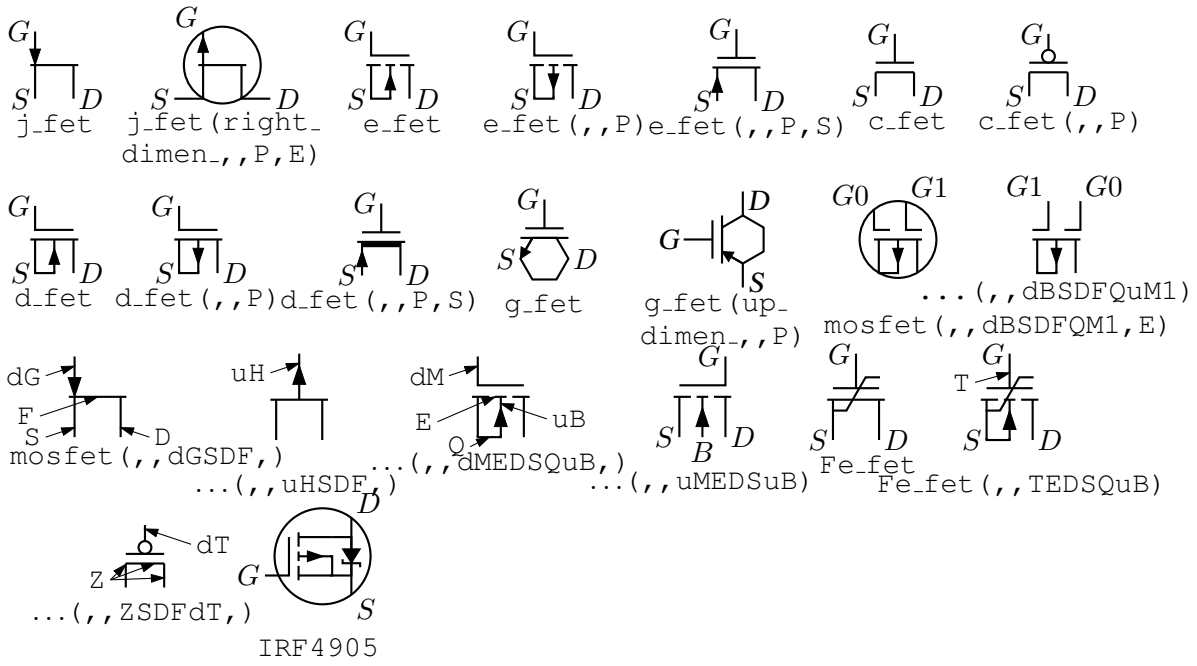


Figure 32: FETs, showing programmable components and example customizations [fet.m4].

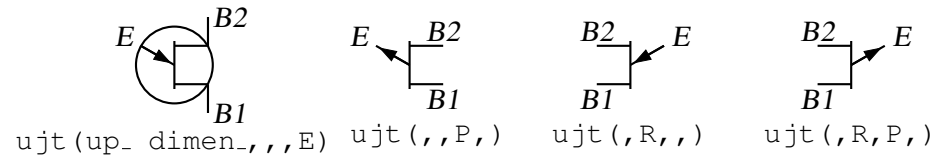


Figure 33: UJT examples `[ujt.m4]`.

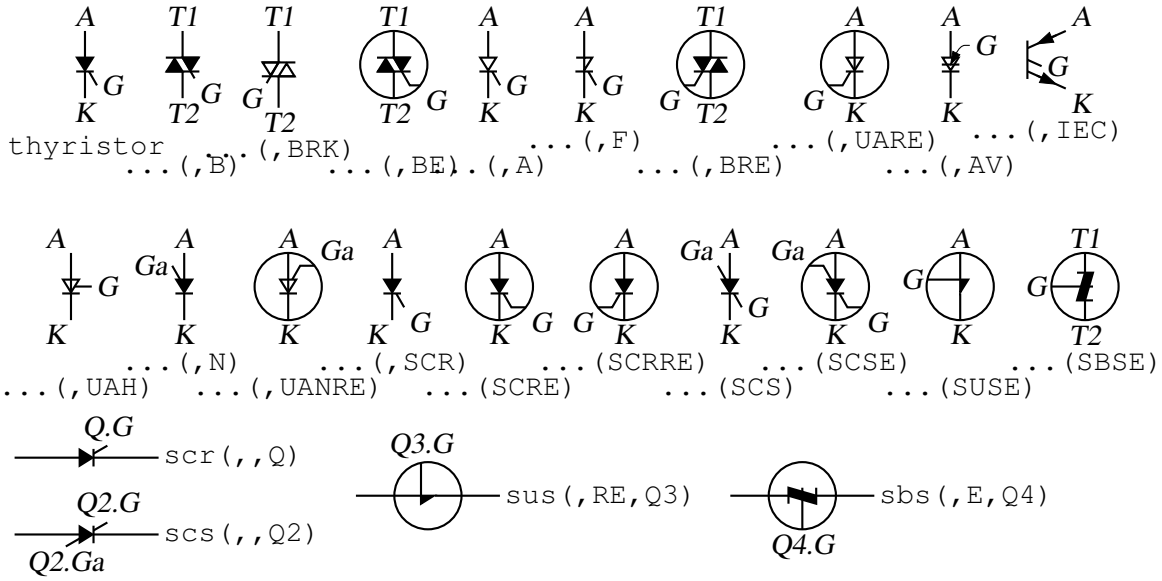


Figure 34: Thyristor examples. The thyristor is a 3- or 4-terminal composite element `[thyristor.m4]`.

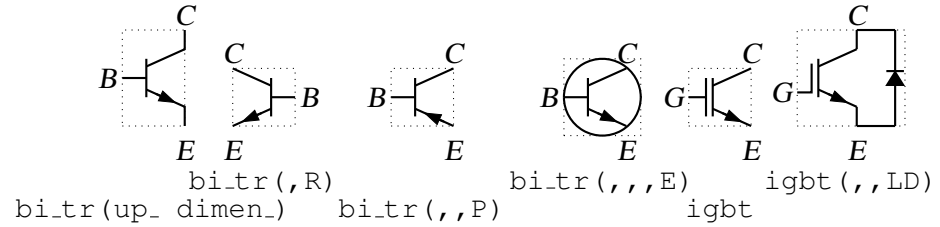


Figure 35: Bipolar transistors (drawing direction: up) `[Bip.m4]`.

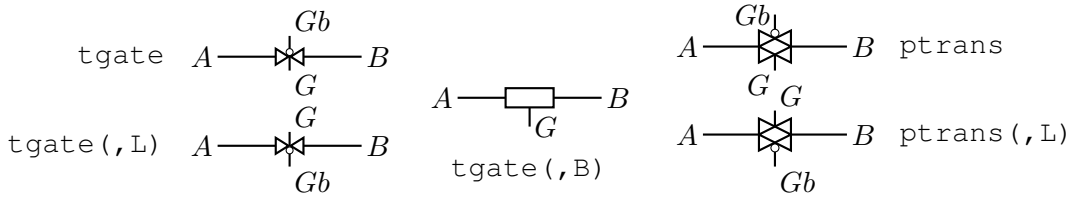


Figure 36: The `tgate` and `ptrans` elements `[Tgate.m4]`.

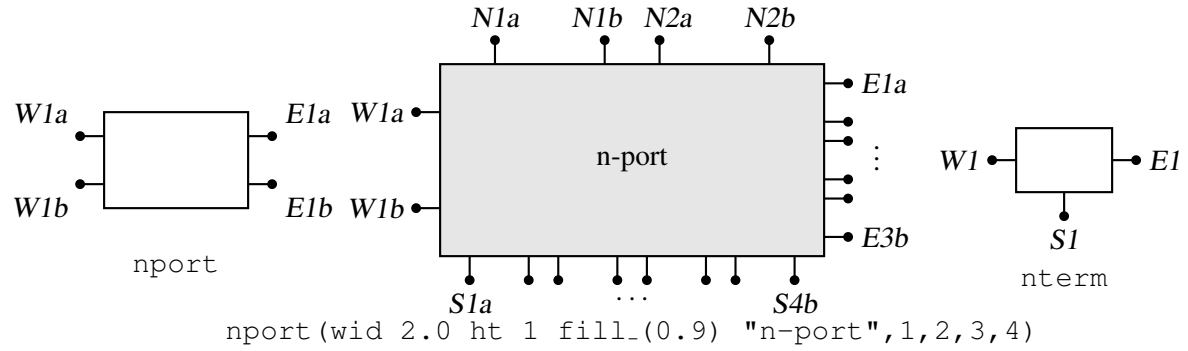


Figure 37: The `nport` and `nterm` macros `[Nport.m4]`.

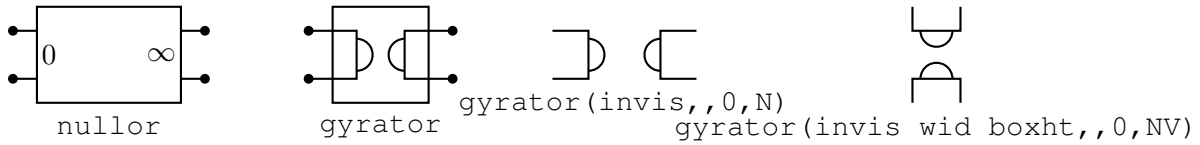


Figure 38: Some customizations of `nport` `[NLG.m4]`.

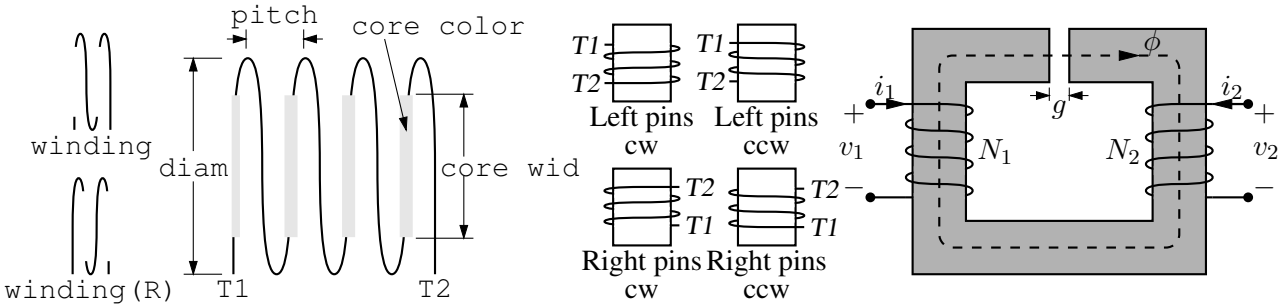


Figure 39: The macro `winding(L|R,diam,pitch,turns,core wid,core color)` `[Windings.m4]`.

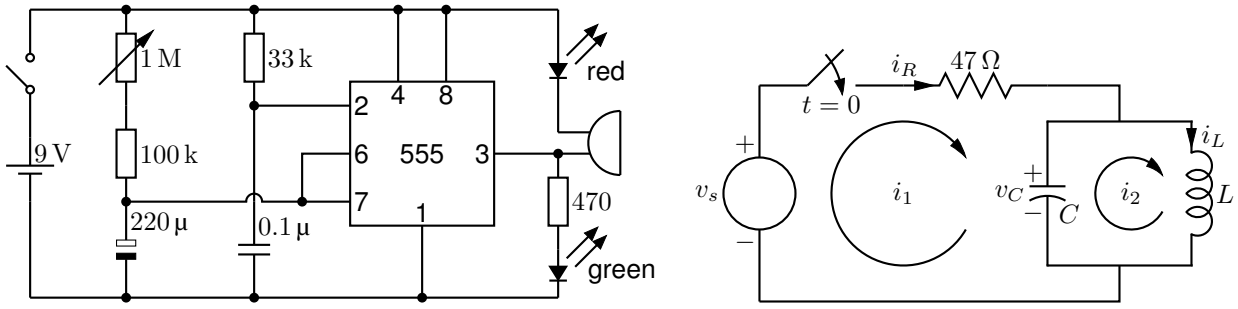


Figure 40: Two simple labeled circuits `[ex01.m4]`.

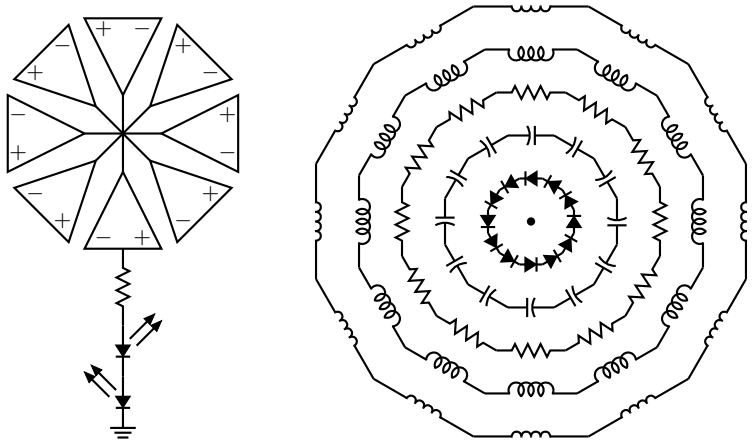


Figure 41: Elements at obtuse angles [ex02.m4].

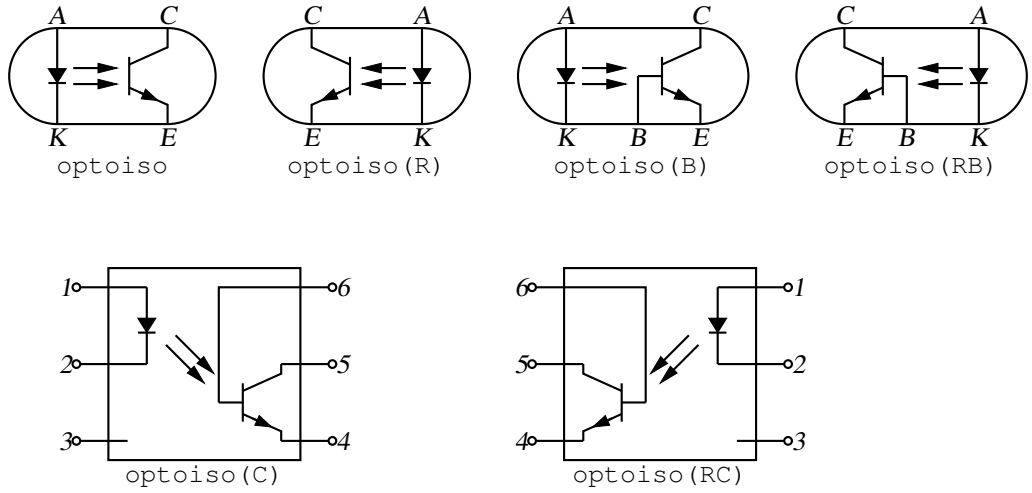


Figure 42: Optical isolator: a circuit with right or left orientation [Optoiso.m4].

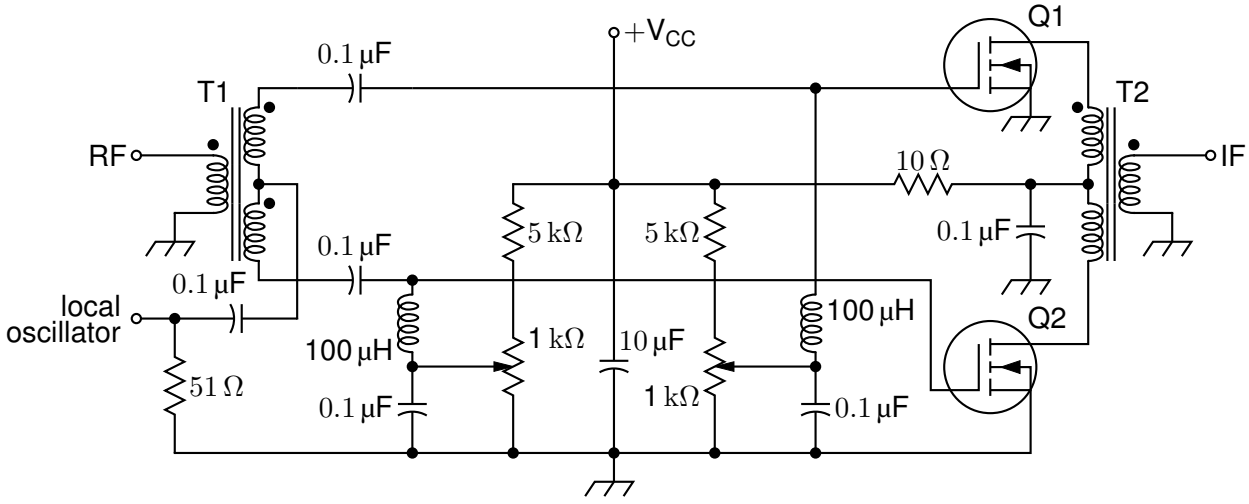


Figure 43: A balanced mixer, using mosfet and a custom transformer [Mixer.m4].

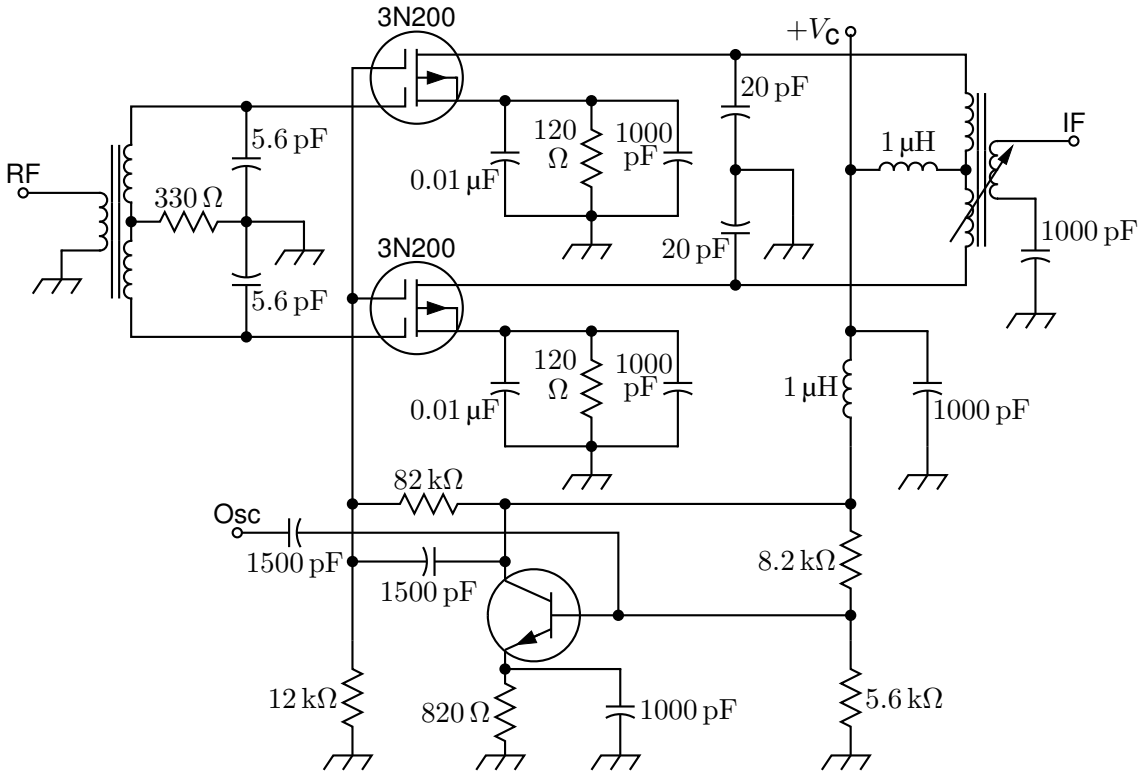


Figure 44: A push-pull mixer, showing FETs with multiple gates `[PushPull.m4]`.

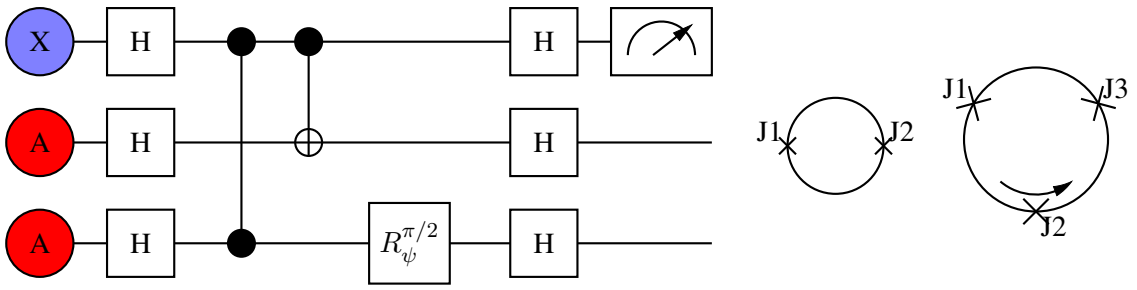


Figure 45: A quantum circuit and a superconducting quantum interface device (drawing direction down) `[Quantum.m4]`.

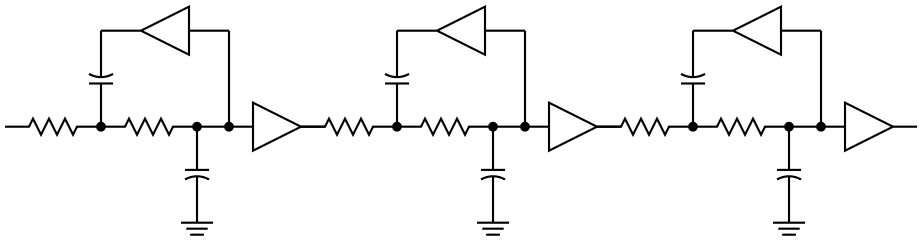


Figure 46: A six-pole filter `[Sixpole.m4]`.

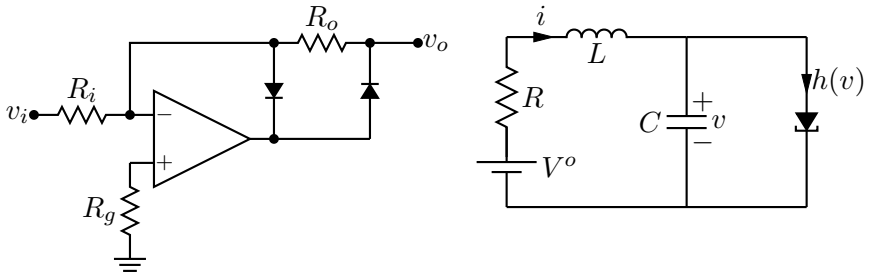


Figure 47: Precision half-wave rectifier and a tunnel diode circuit (illustrating `opamp`, `diode`, `resistor`, `ground`, and labels) `[ex18.m4]`.

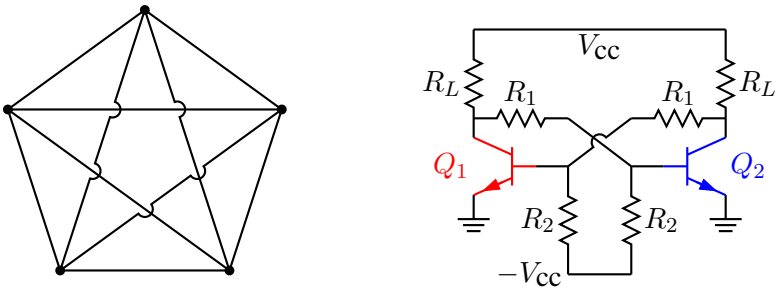


Figure 48: Non-planar graph and bistable circuit (illustrating the `crossover` macro and colored elements) `[ex10.m4]`.

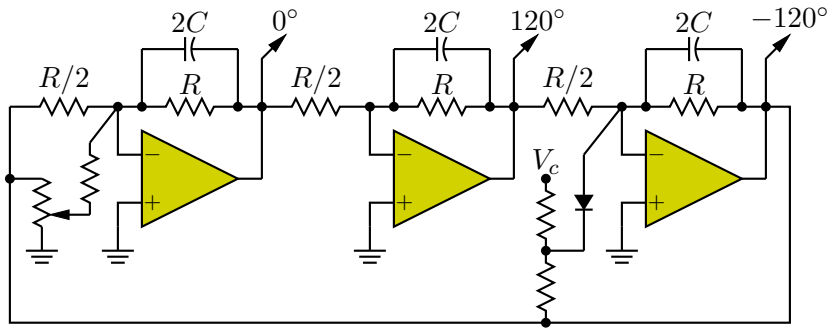


Figure 49: Three-phase oscillator `[Three.m4]`.

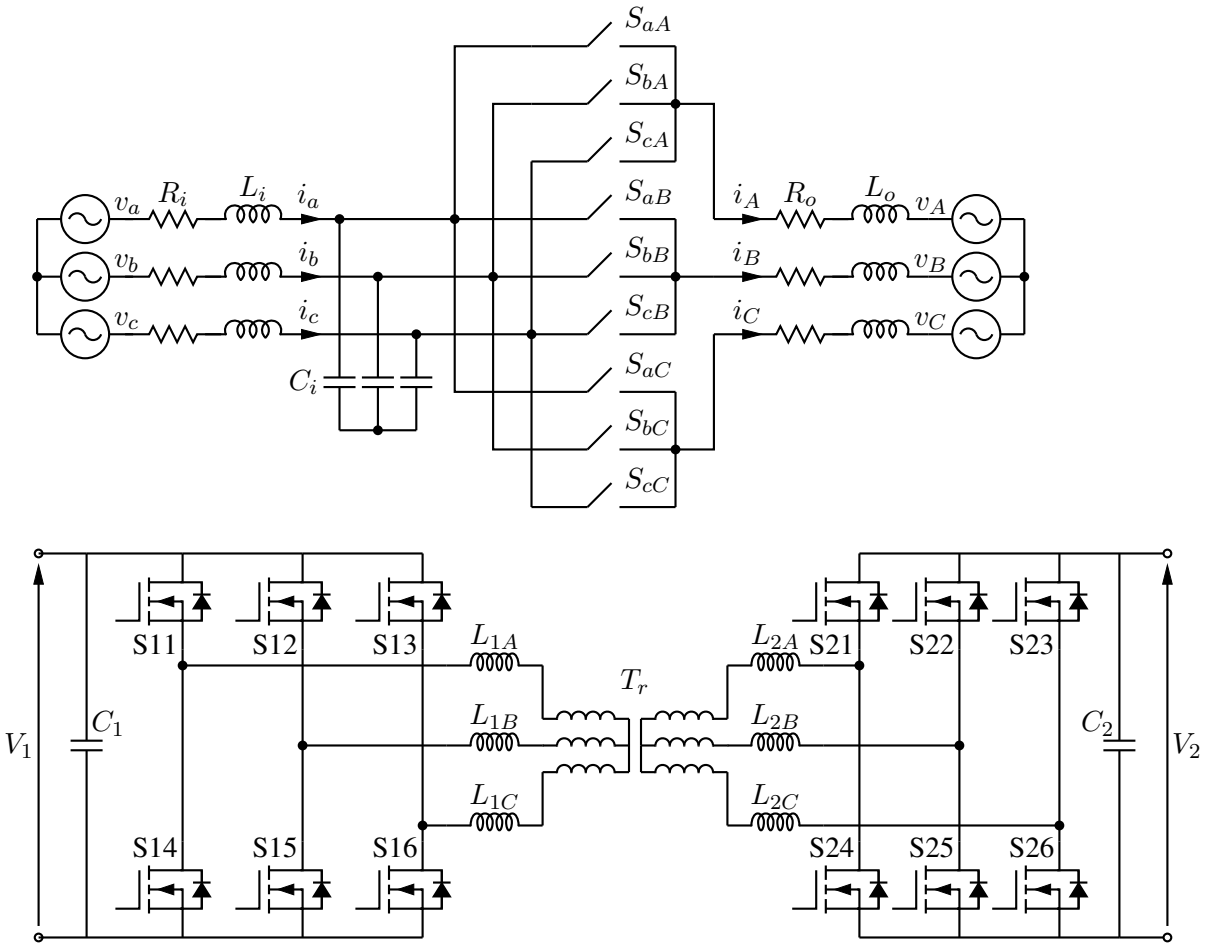


Figure 50: A three-phase switched AC-AC converter and a DC-DC converter `[MC.m4]`.

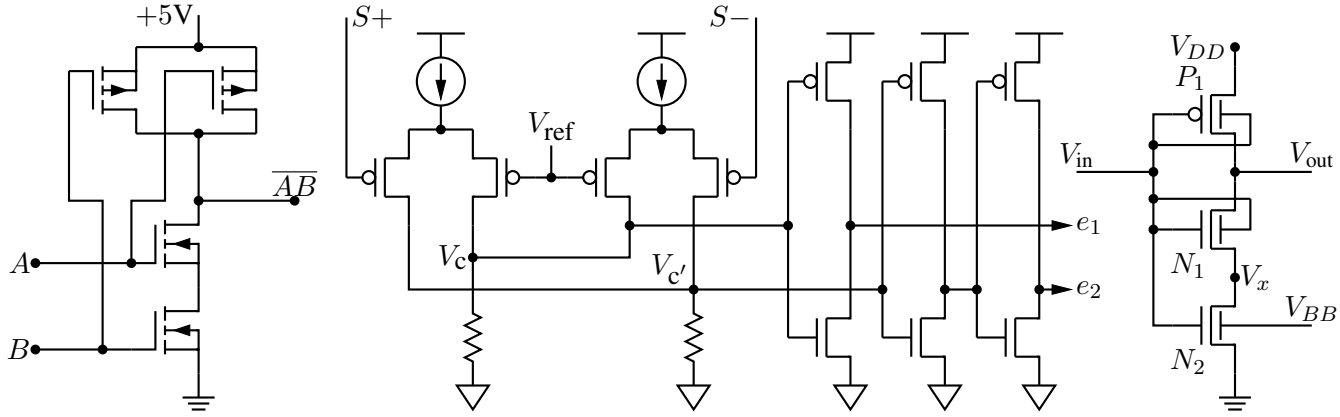


Figure 51: A CMOS NAND gate, a test circuit, and an XMOSFET example `[ex12.m4]`.

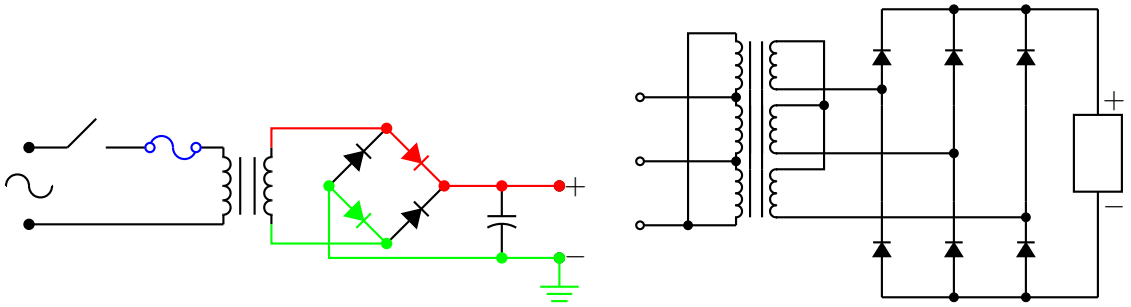


Figure 52: An elementary power supply circuit with colored elements, and a multiple-winding transformer with 3-phase rectifier `[pwrsupply.m4]`.

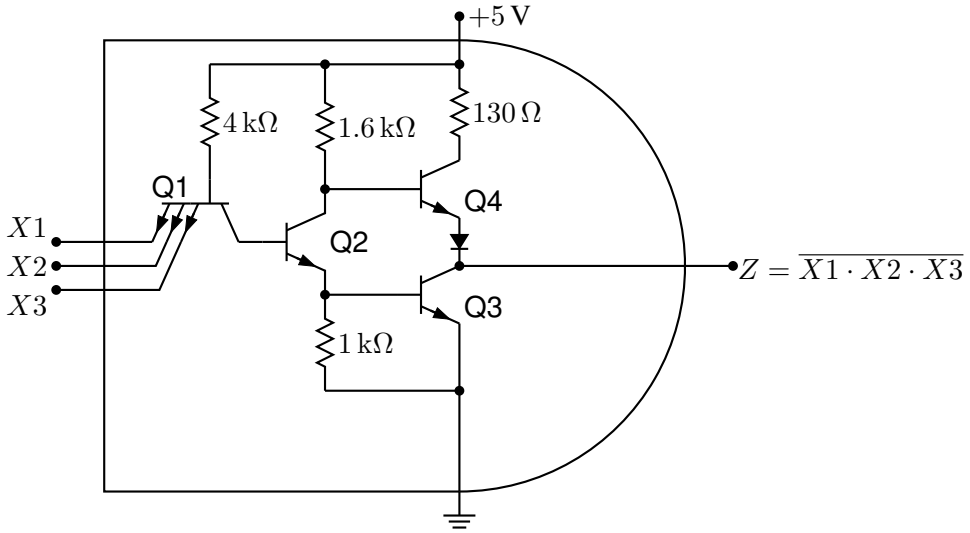


Figure 53: TTL NAND gate illustrating a transistor with multiple emitters `[TTLnand.m4]`.

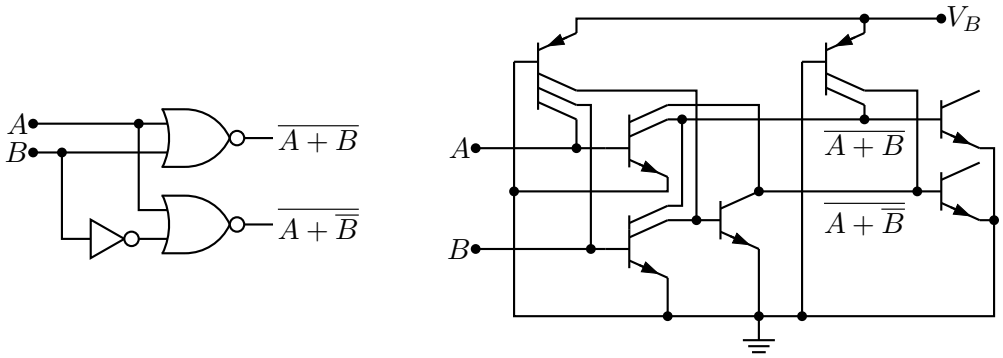


Figure 54: Gate circuit and equivalent embedded I^2L components illustrating multiple collectors `[I2L.m4]`.

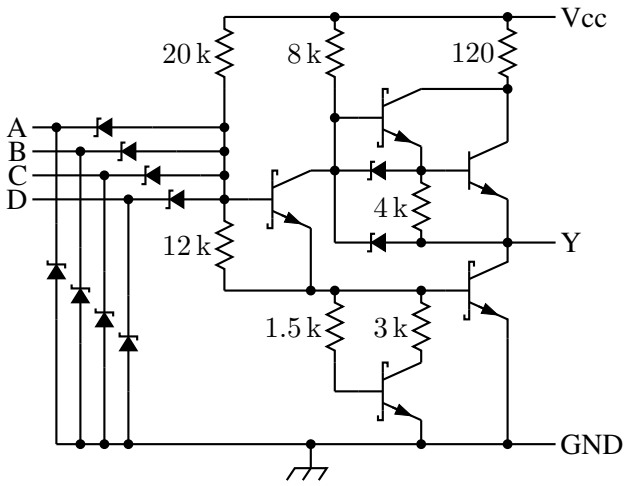


Figure 55: A 4-input NAND circuit illustrating the `S` (Schottky) option of `bi_trans [Schottky.m4]`.

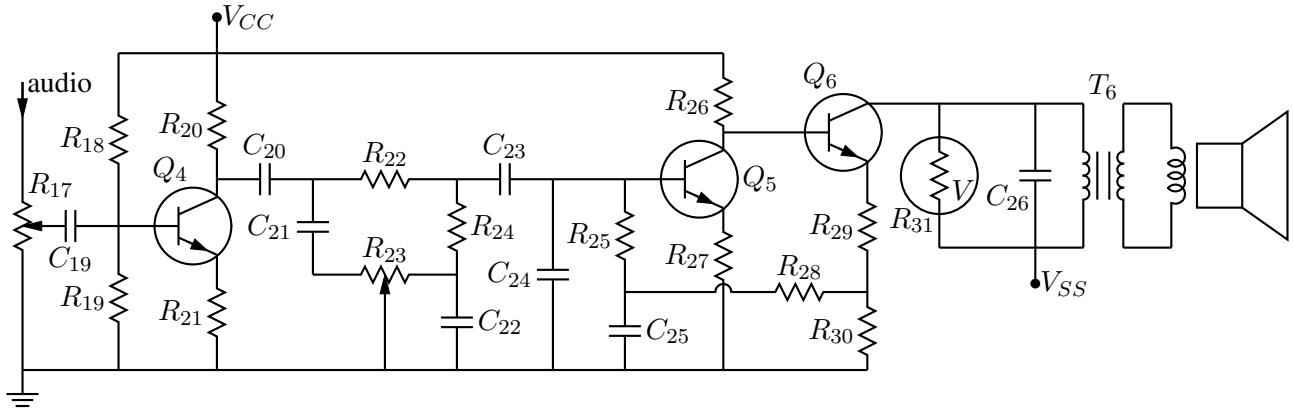


Figure 56: Transistor radio audio chain `[ex11.m4]`.

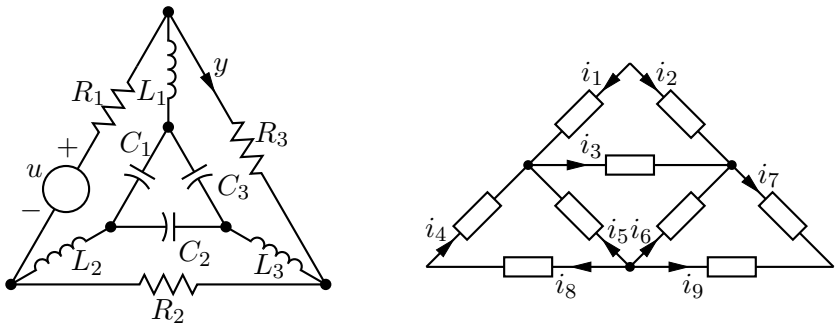


Figure 57: Labels on non-manhattan elements `[ex04.m4]`.

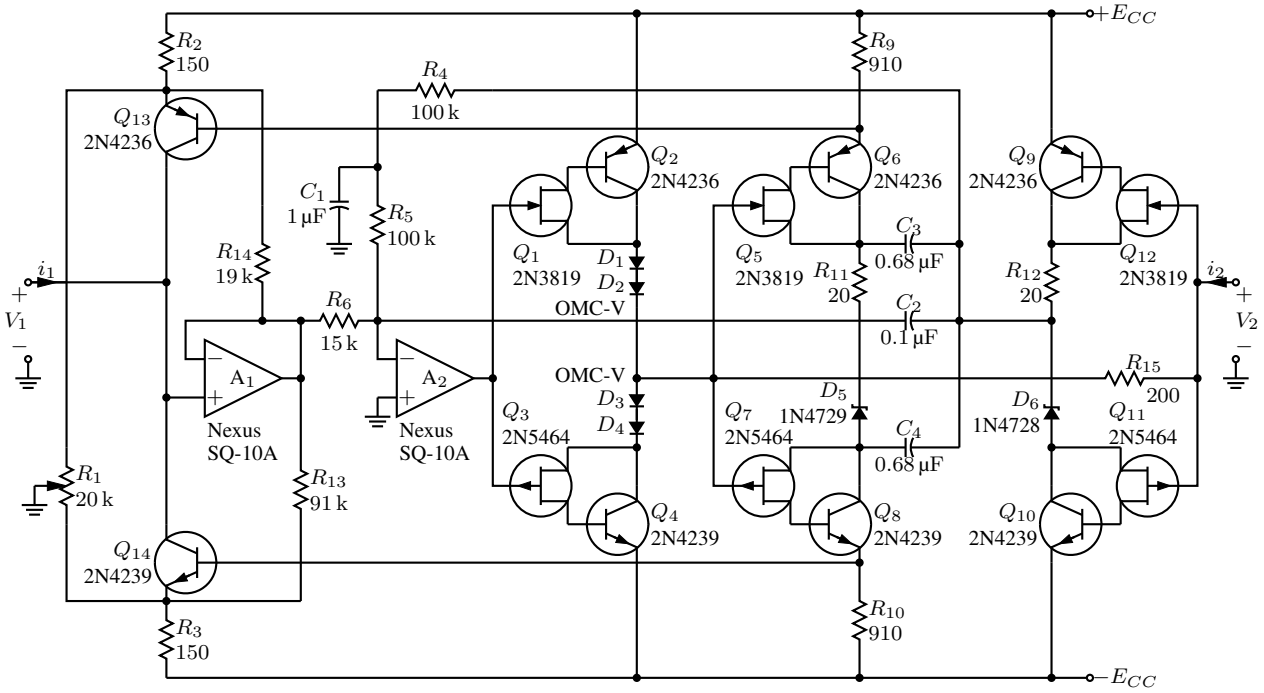


Figure 58: Realization of a controlled source (illustrating stacked element labels) `[Csource.m4]`.

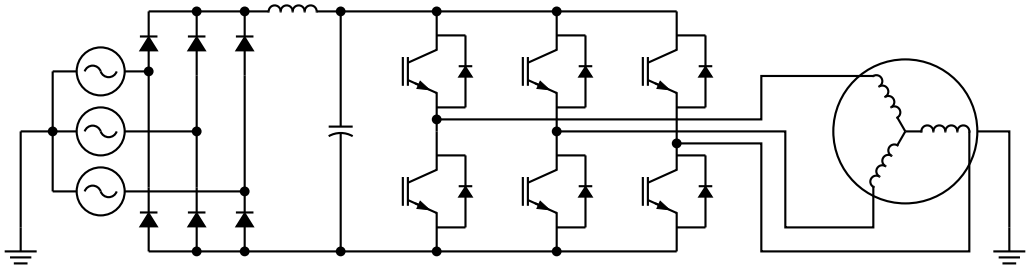


Figure 59: Synchronous machine driven by variable-speed drive and rectifier `[Drive.m4]`.

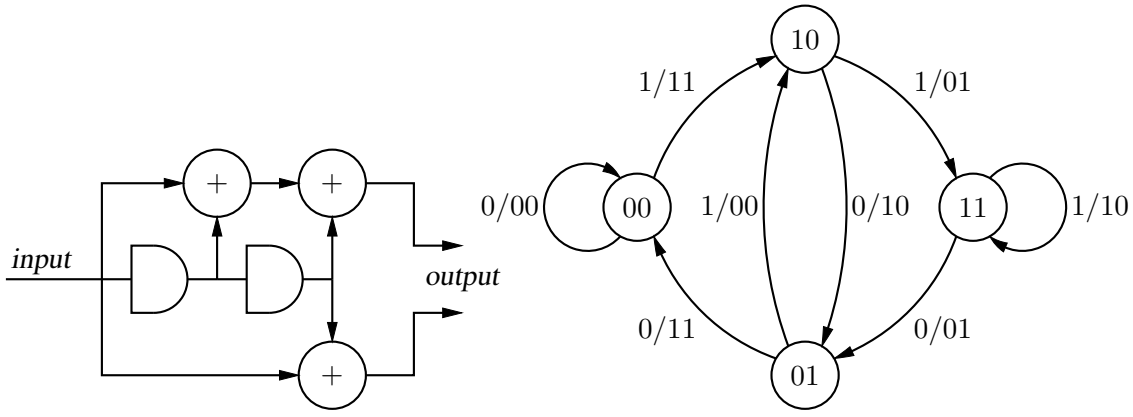


Figure 60: A rate $1/2$ binary convolutional coder and its state diagram `[ex16.m4]`.

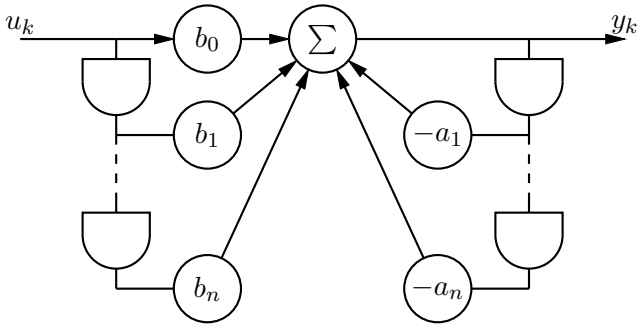


Figure 61: Digital filter `[ex03.m4]`.

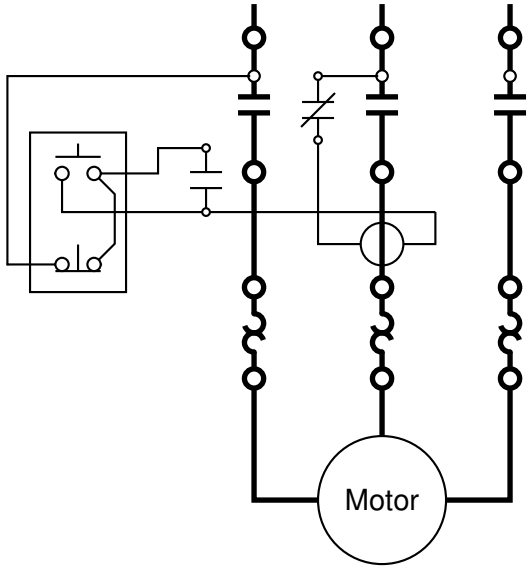


Figure 62: Motor control connections `[MotorControl.m4]`.

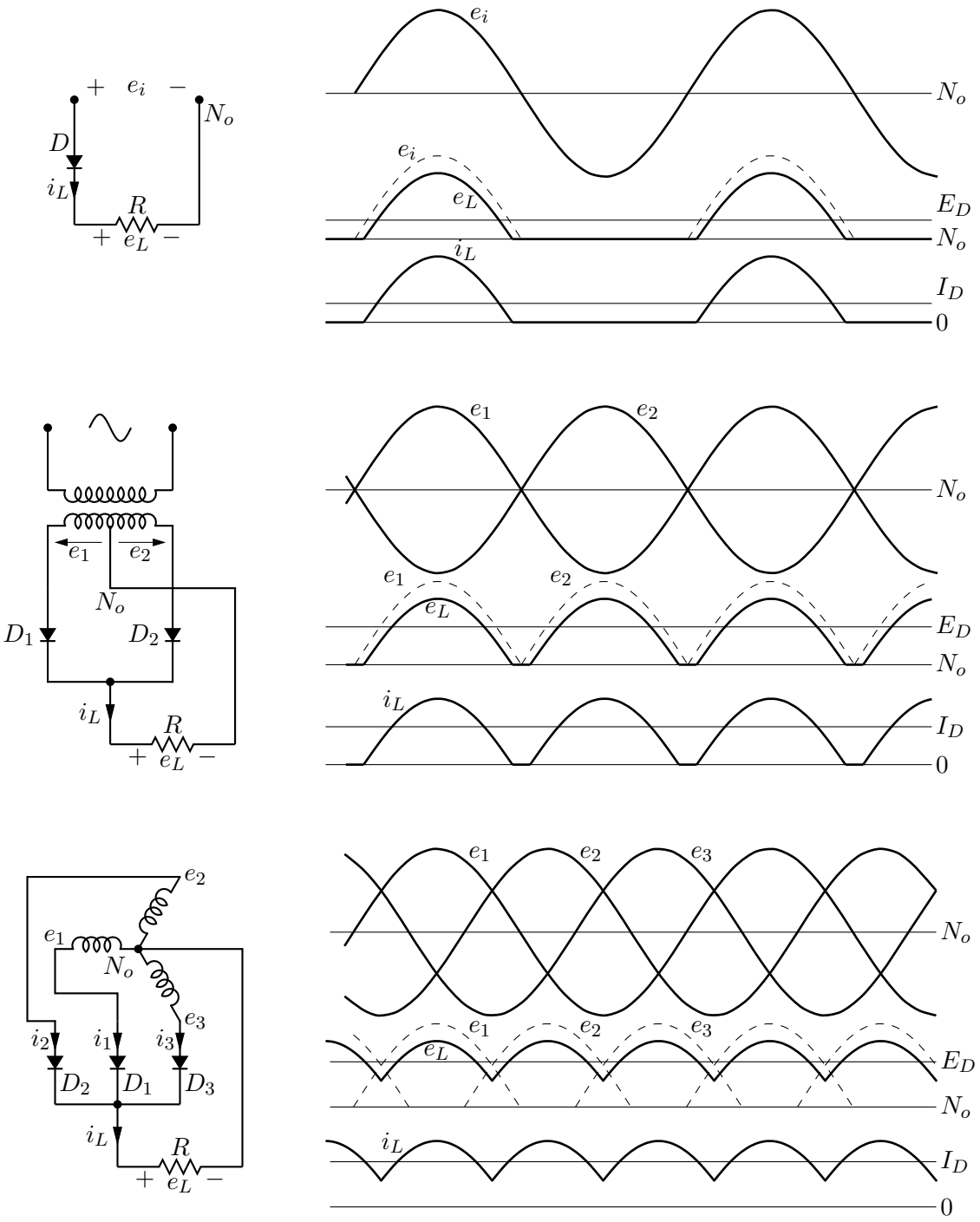


Figure 63: Rectifier circuits and waveforms `[Rectifiers.m4]`.

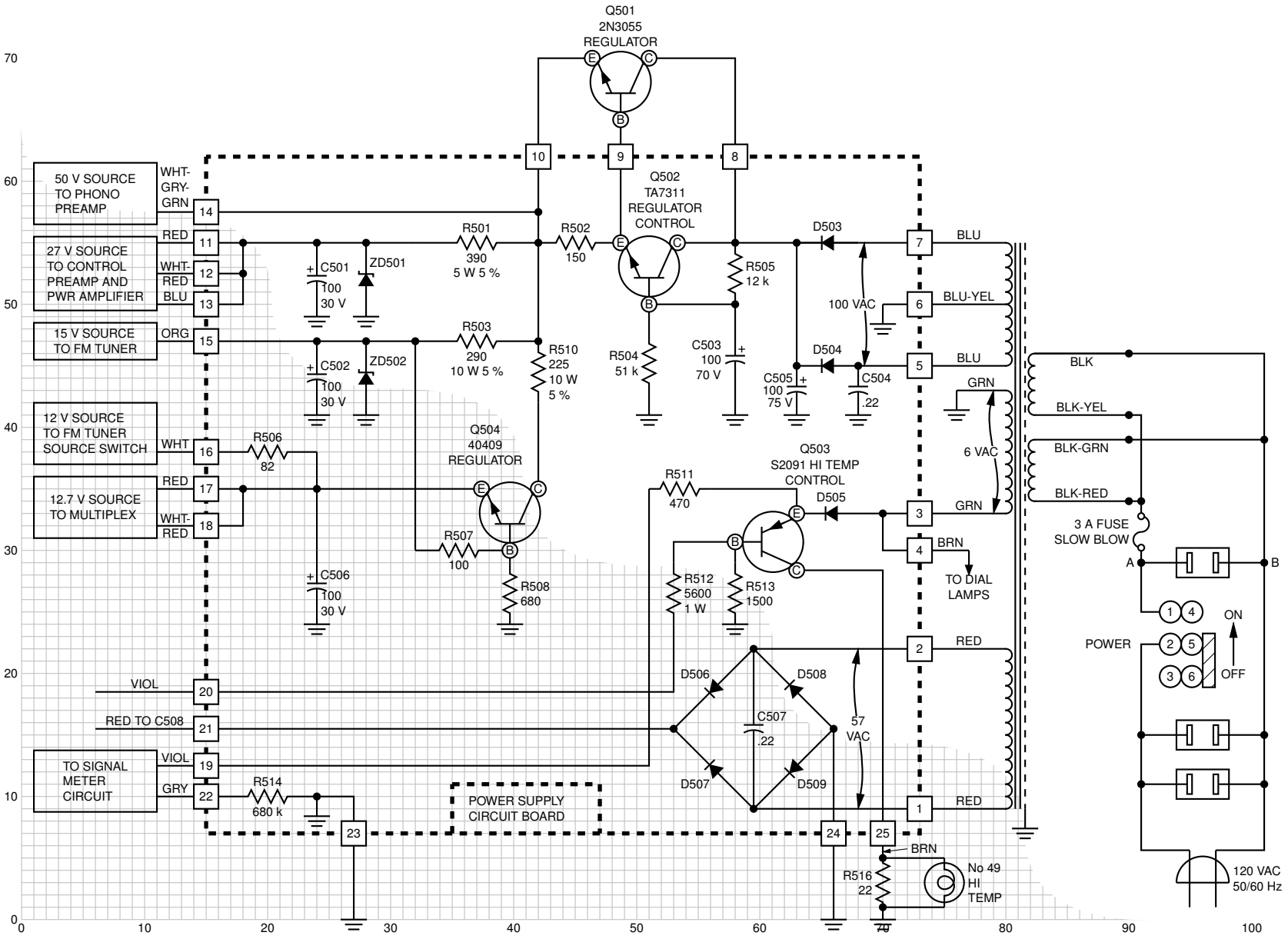


Figure 64: The power supply of a Heathkit AR-15 (Now, *that* was a receiver!) with custom transformer and other elements, drawn on a grid (partially shown) to aid in placement `[Heathkit.m4]`.

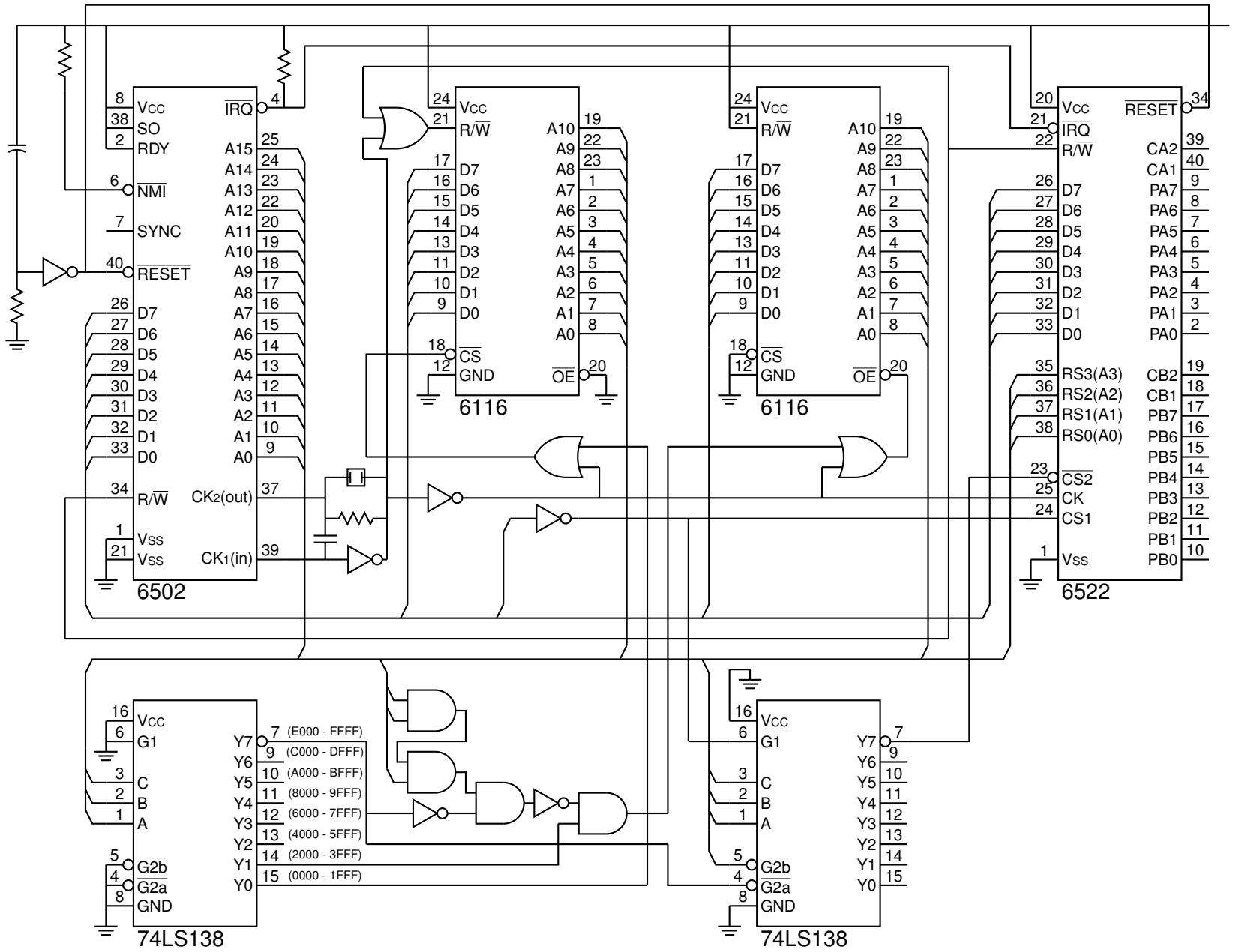


Figure 65: A digital circuit of moderate size, redrawn from M. P. Maclenan and G. M. Burns, “An Approach to Drawing Circuit Diagrams for Text Books,” Tugboat (12)1, March 1991, pp. 66-69 `[lcct.m4]`.

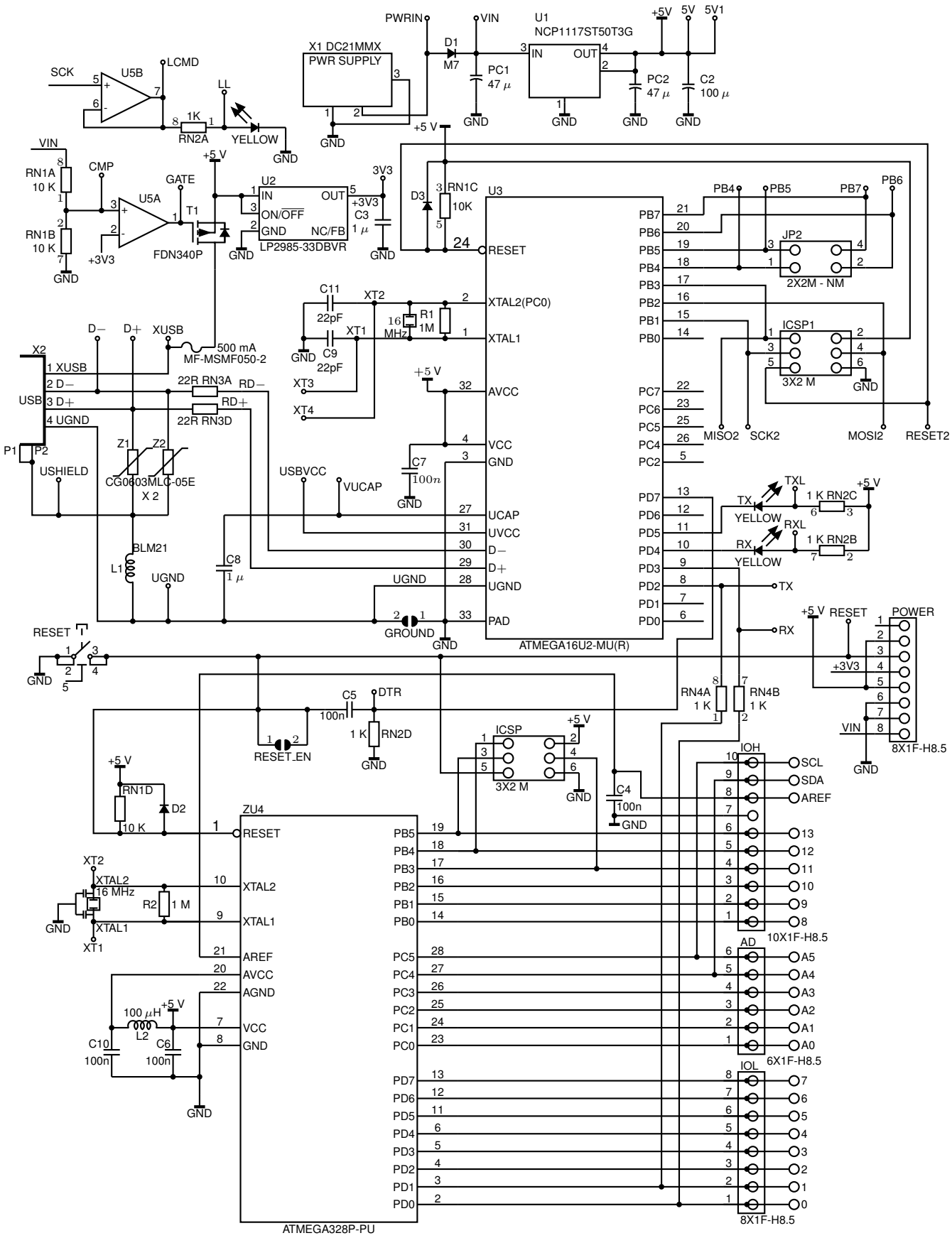


Figure 66: An Arduino UNO circuit adapted and redrawn [UNO.m4].

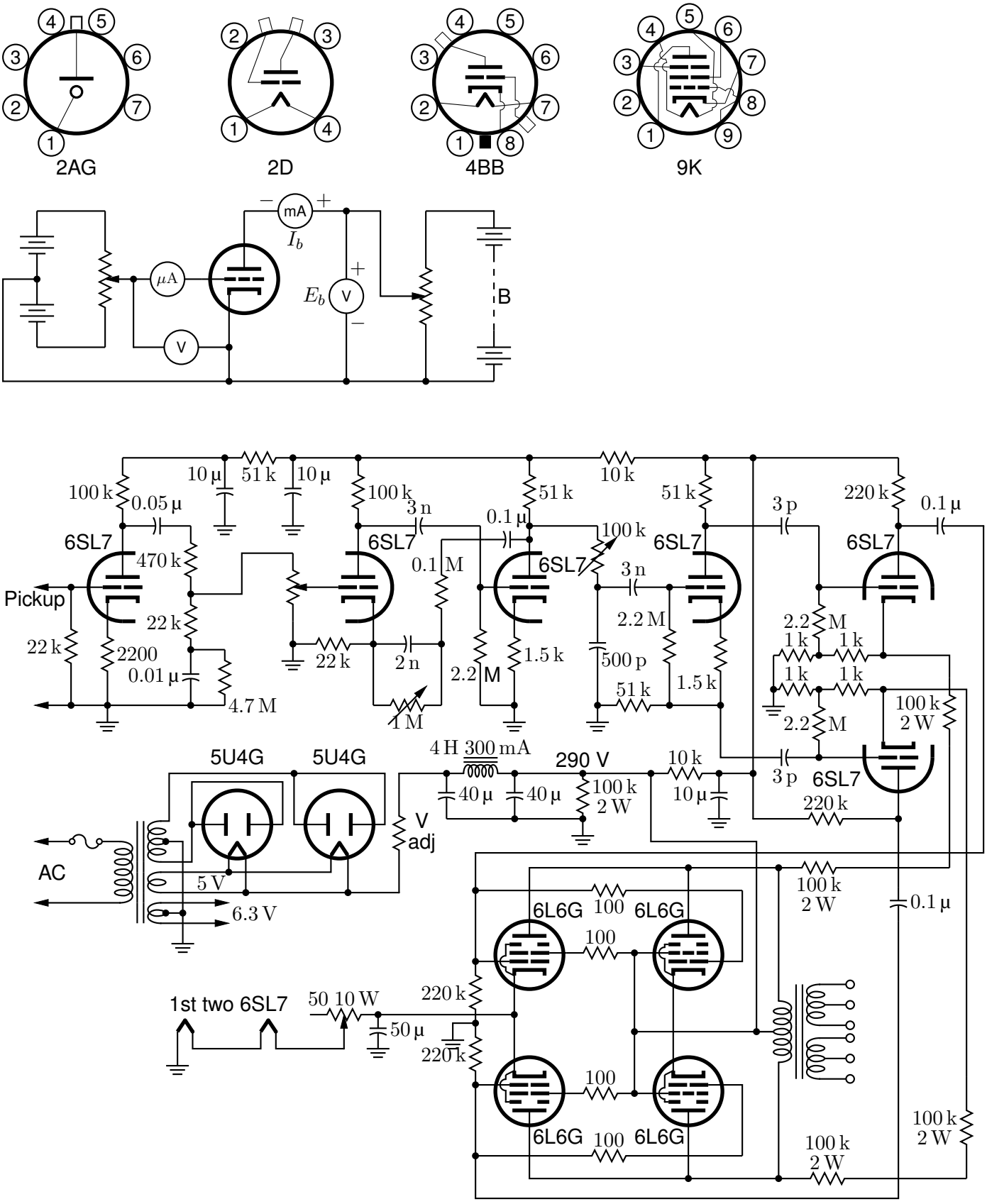


Figure 67: Electron-tube diagrams: a few bottom-view base diagrams, a generic triode test circuit, and a 25-watt audio amplifier adapted from F. Langford-Smith, *Radiotron Designer's Handbook,* fourth edition, Harrison, NJ: Radio Corporation of America, 1952 `[Tubediags.m4]`.

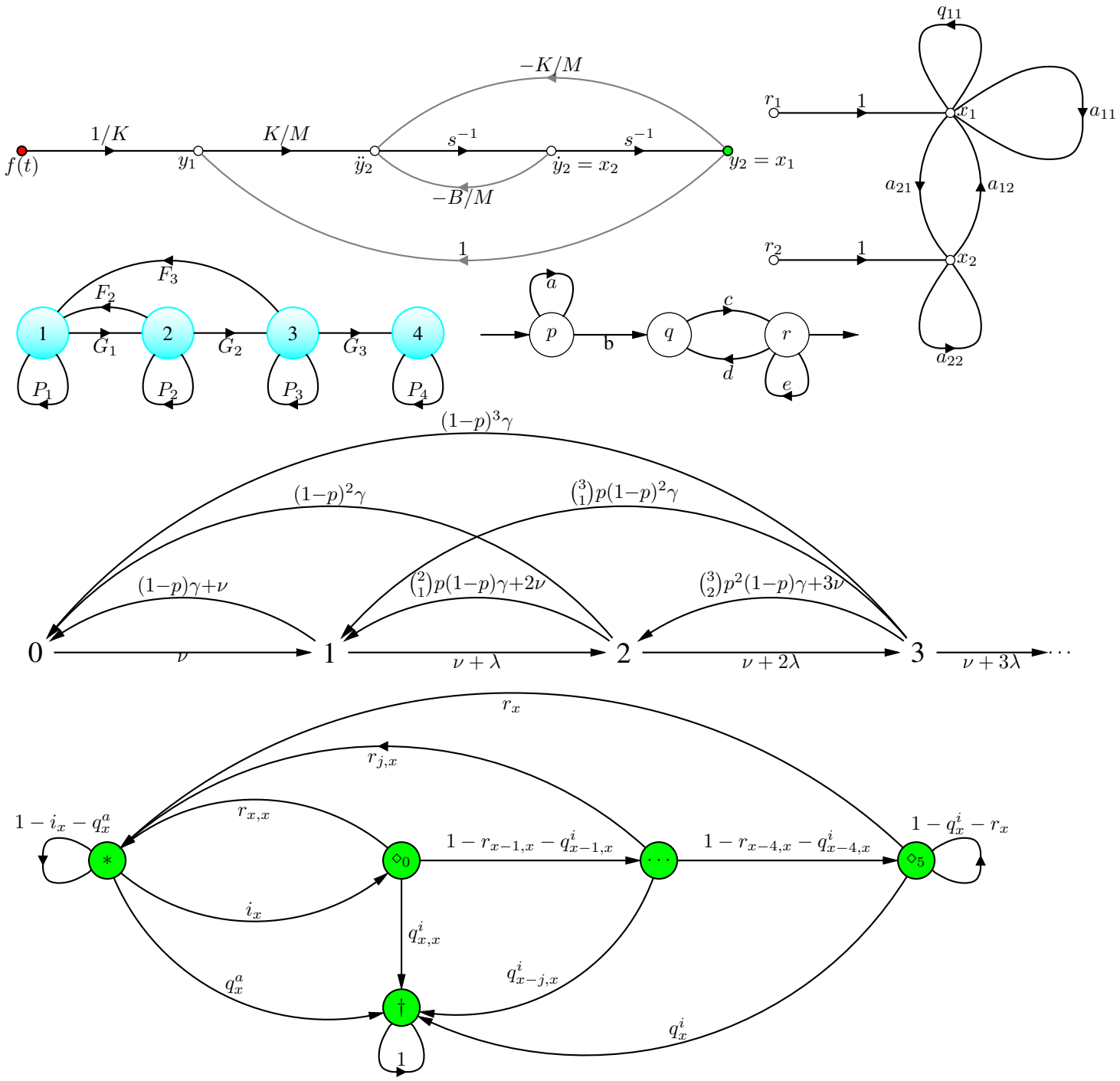


Figure 68: Signal-flow graphs `[sfg.m4]`.

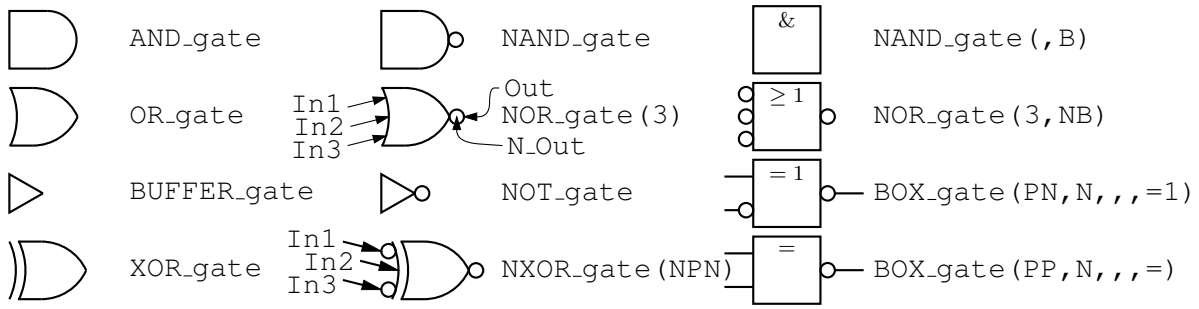


Figure 69: Basic logic gates [Logic.m4].

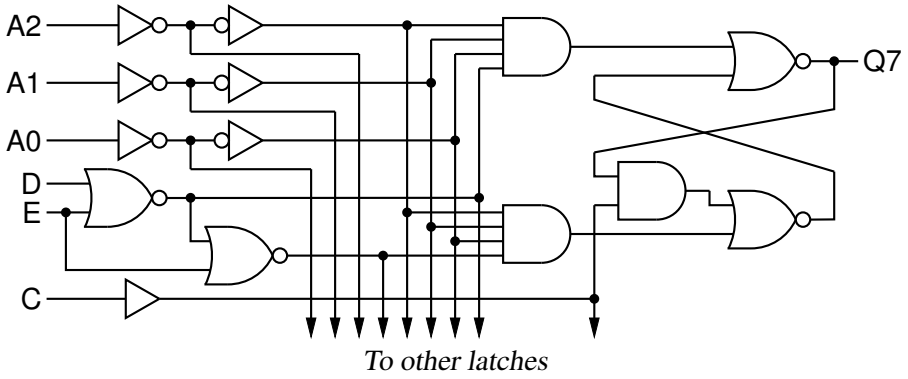


Figure 70: General-purpose latch: a small logic circuit [ex08.m4].

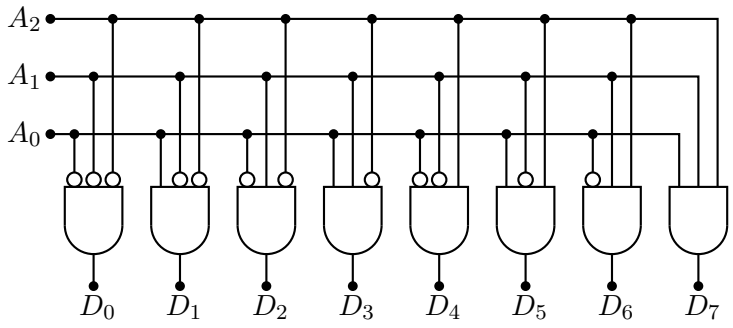


Figure 71: Decoder logic, constructed using the for_ macro [Decoder.m4].

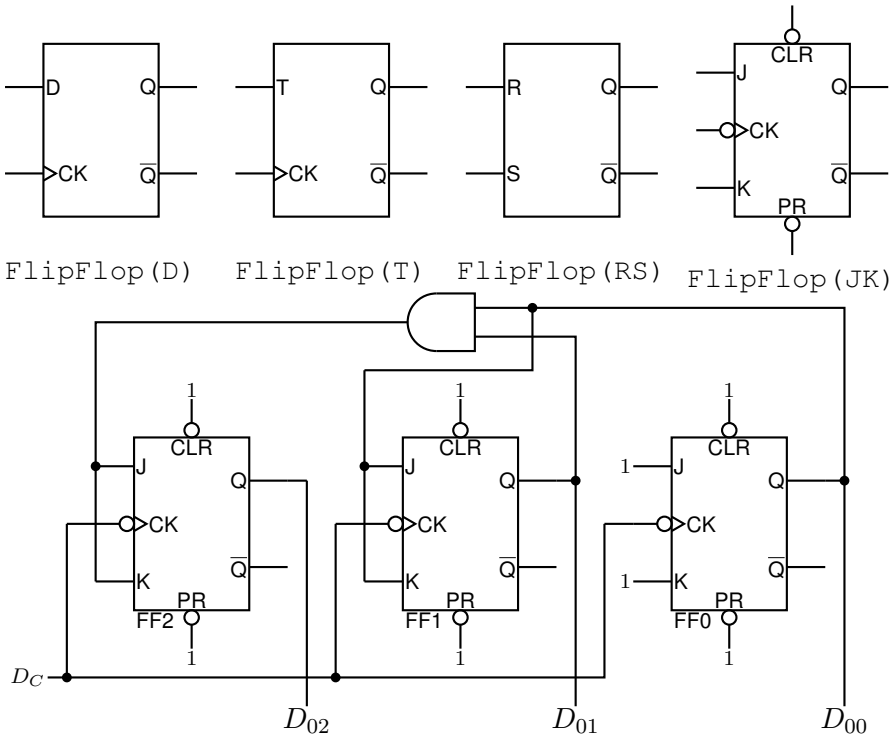


Figure 72: Some flip-flops [ex21.m4].

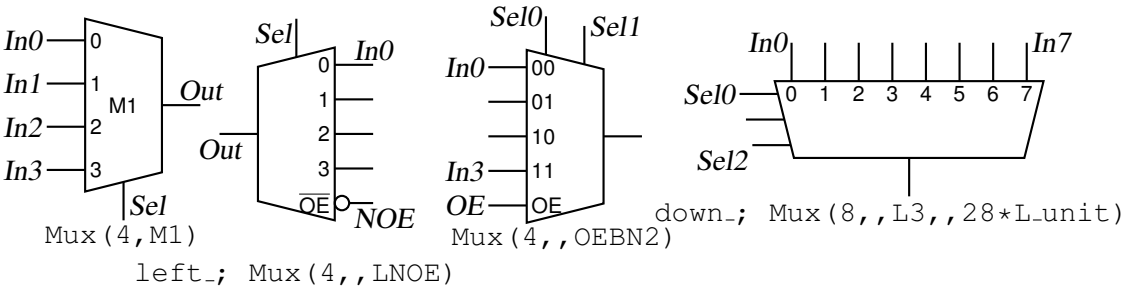


Figure 73: Multiplexer [Multiplexer.m4].

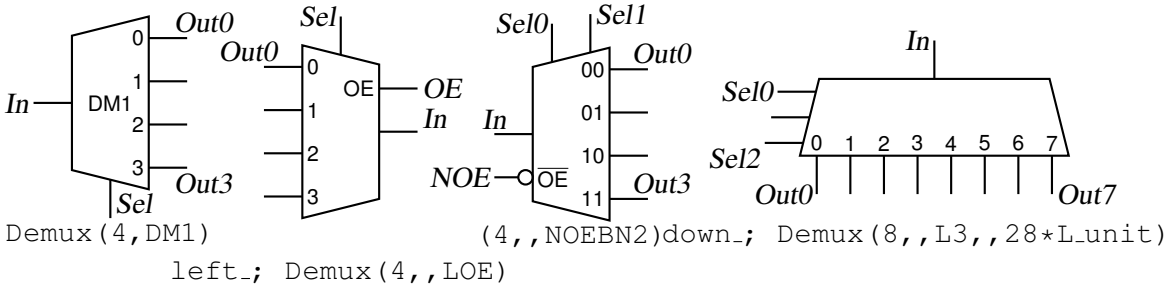


Figure 74: Demultiplexer [Demultiplexer.m4].

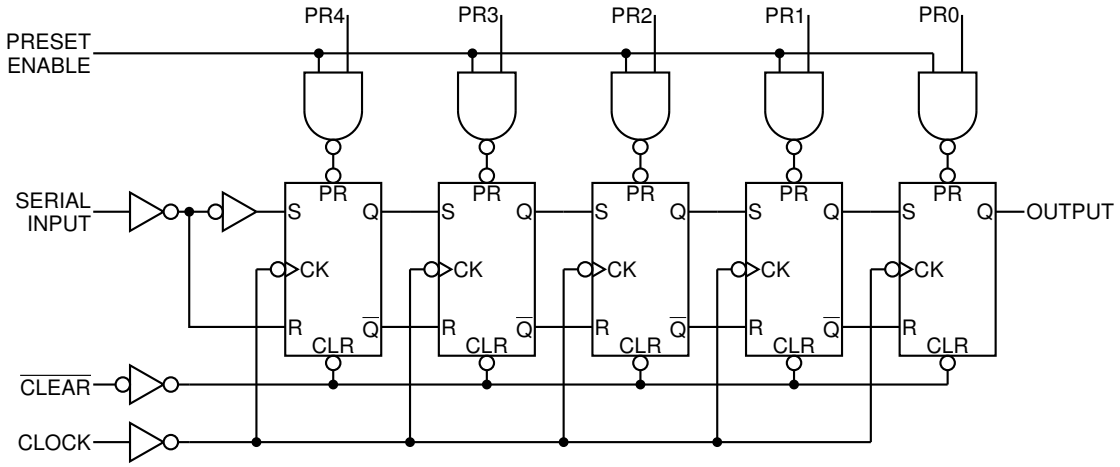


Figure 75: A 5-bit shift register drawn using a custom flip-flop `[ShiftR.m4]`.

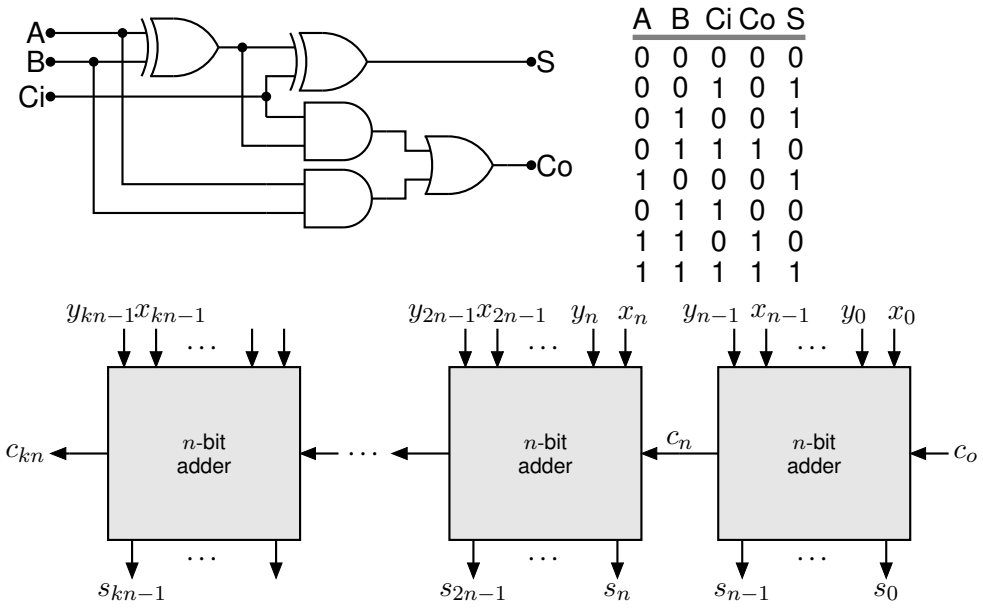
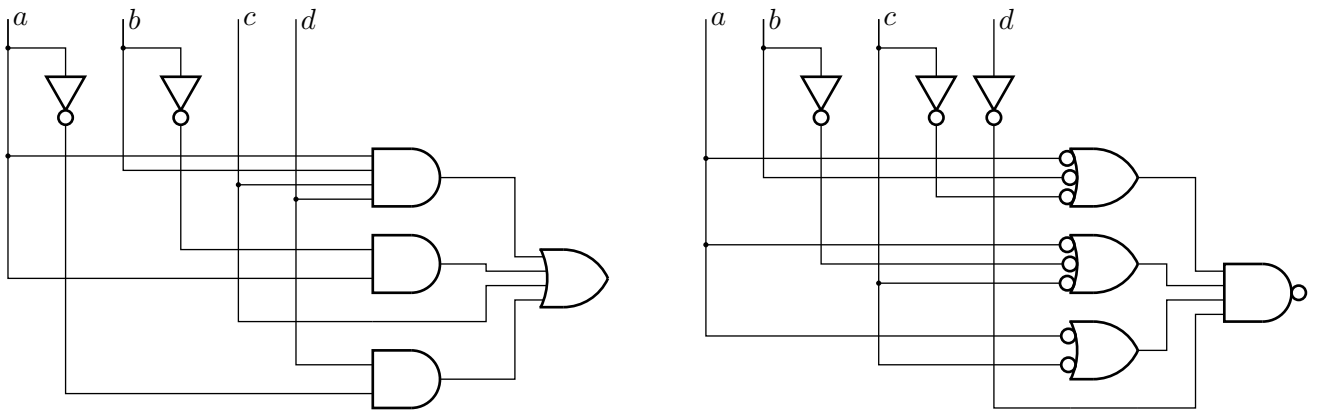


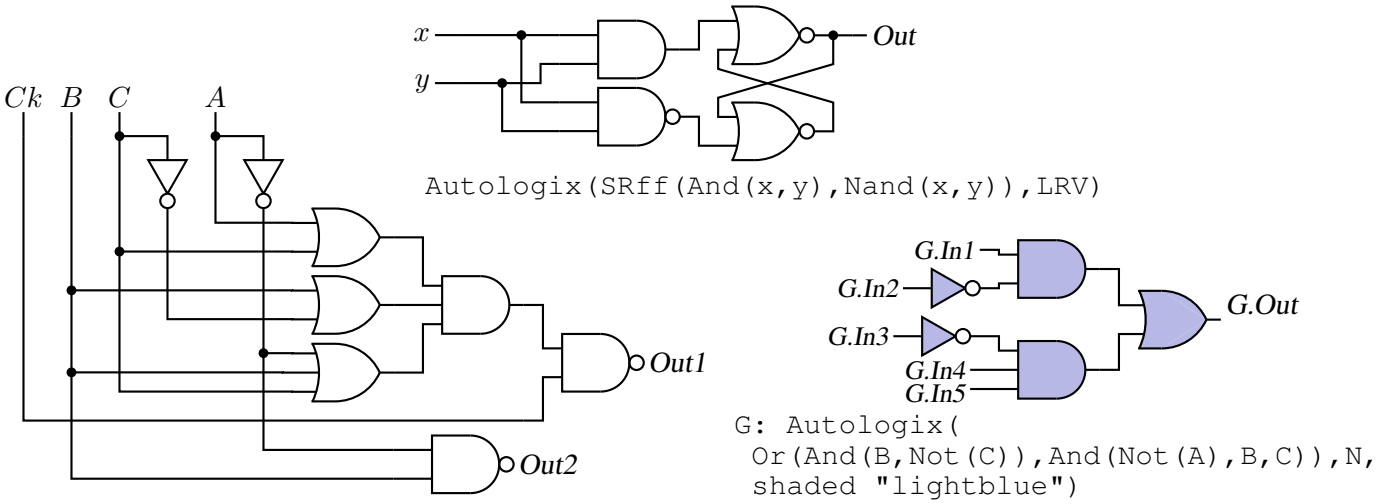
Figure 76: A full adder and a cascade of n-bit adders `[Adder.m4]`.




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

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

Figure 77: A way of automatically drawing two-layer logic diagrams [CanLogic.m4].




```
Autologix(SRff(And(x,y),Nand(x,y)),LRV)
```

```
G: Autologix(
 Or(And(B,Not(C)),And(Not(A),B,C)),N,
 shaded "lightblue")
```

```
Autologix(
  Nand(And(Or(A,C),Or(B,~C),Or(~A,B,C)),Ck);
  Nand(~A,B))@with .n at last [].s+(0,-2bp__))
```

Figure 78: 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].

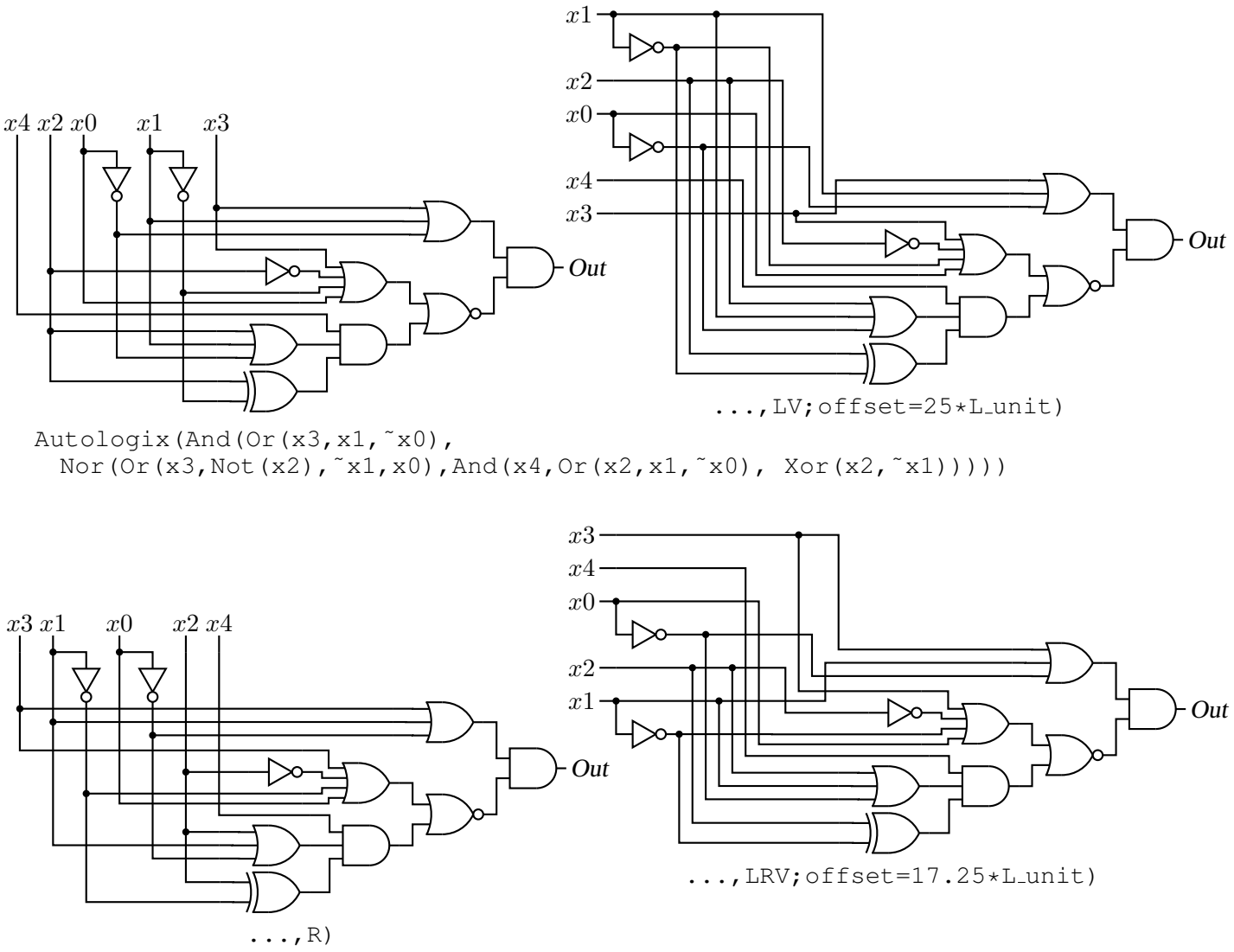


Figure 79: The `Autologix` macro can draw inputs on the left but the added drawing complexity may require hand tuning with second-argument options: `L` puts the inputs on the left, `R` reverses their order, `V` scans the input arguments in reverse order, and `offset=`*value* displaces the array of inputs `[ABlogix.m4]`.

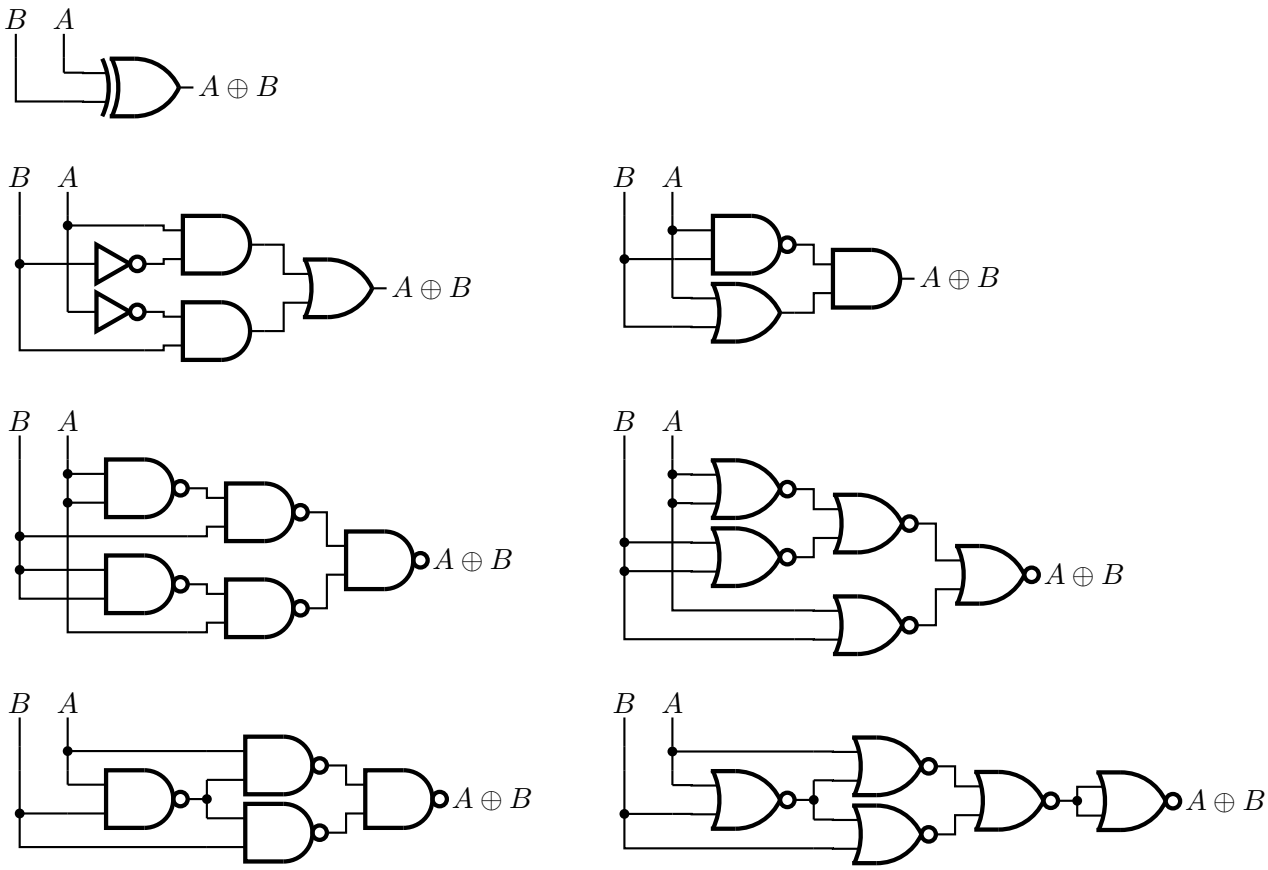


Figure 80: Realizations of the XOR function using `Autologix [XOR.m4]`.

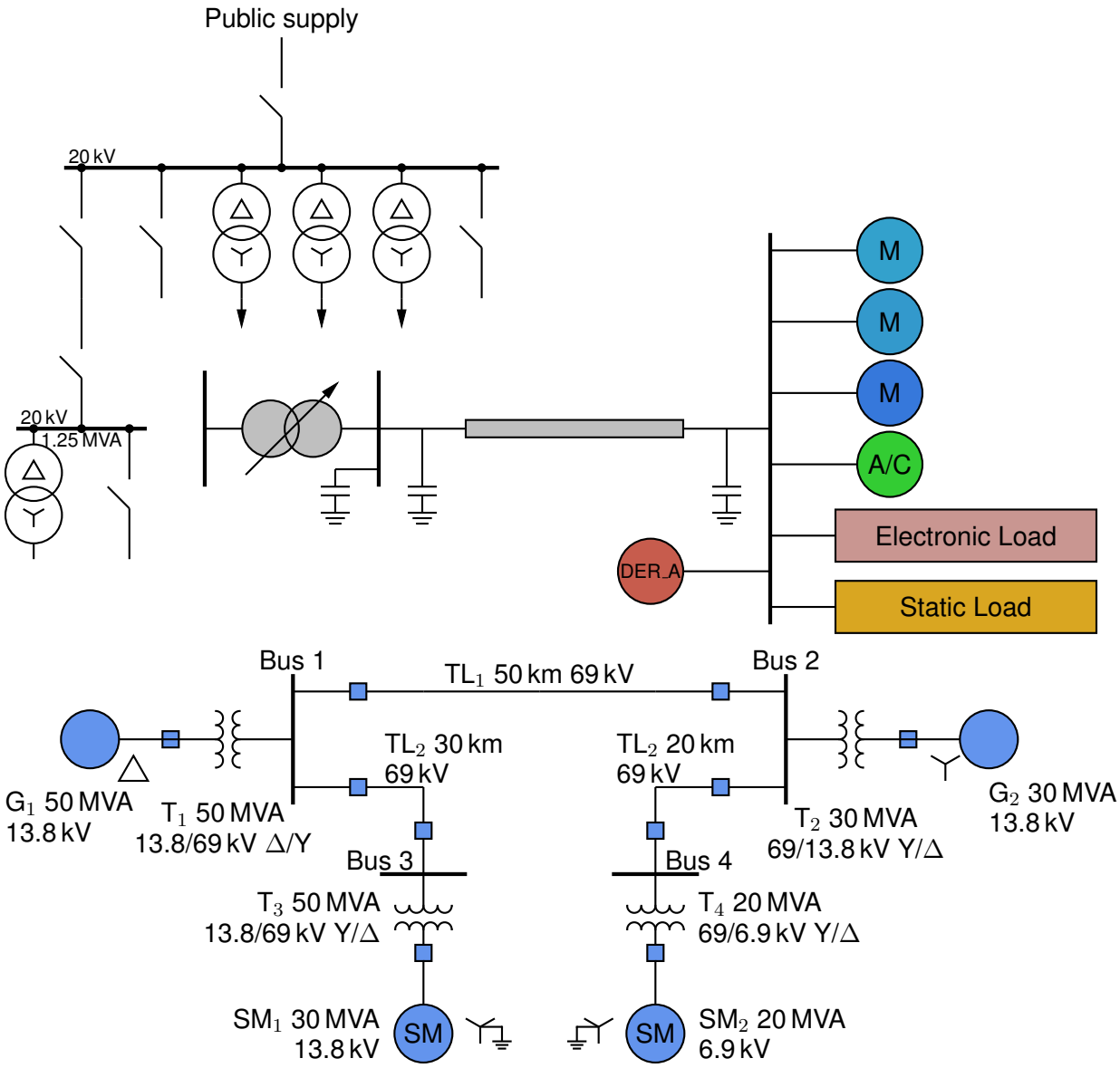


Figure 81: A test of experimental single-line diagram macros `[EEP.m4]`.

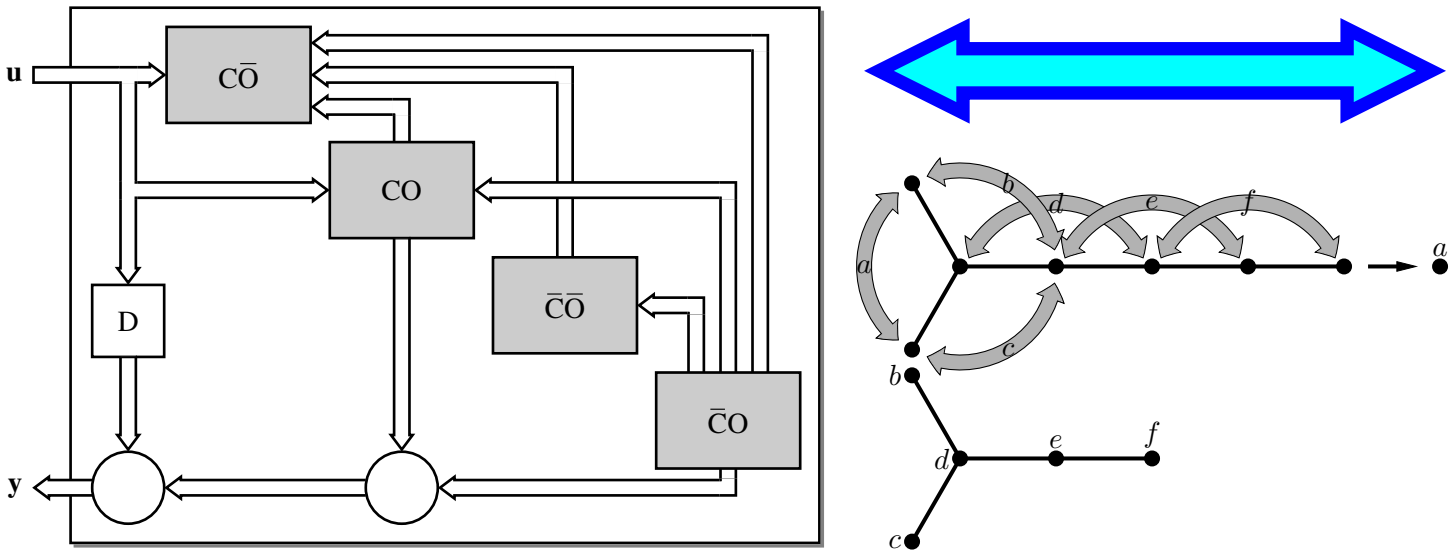


Figure 82: Use of `darrow` and `Darc [ex05.m4]`.

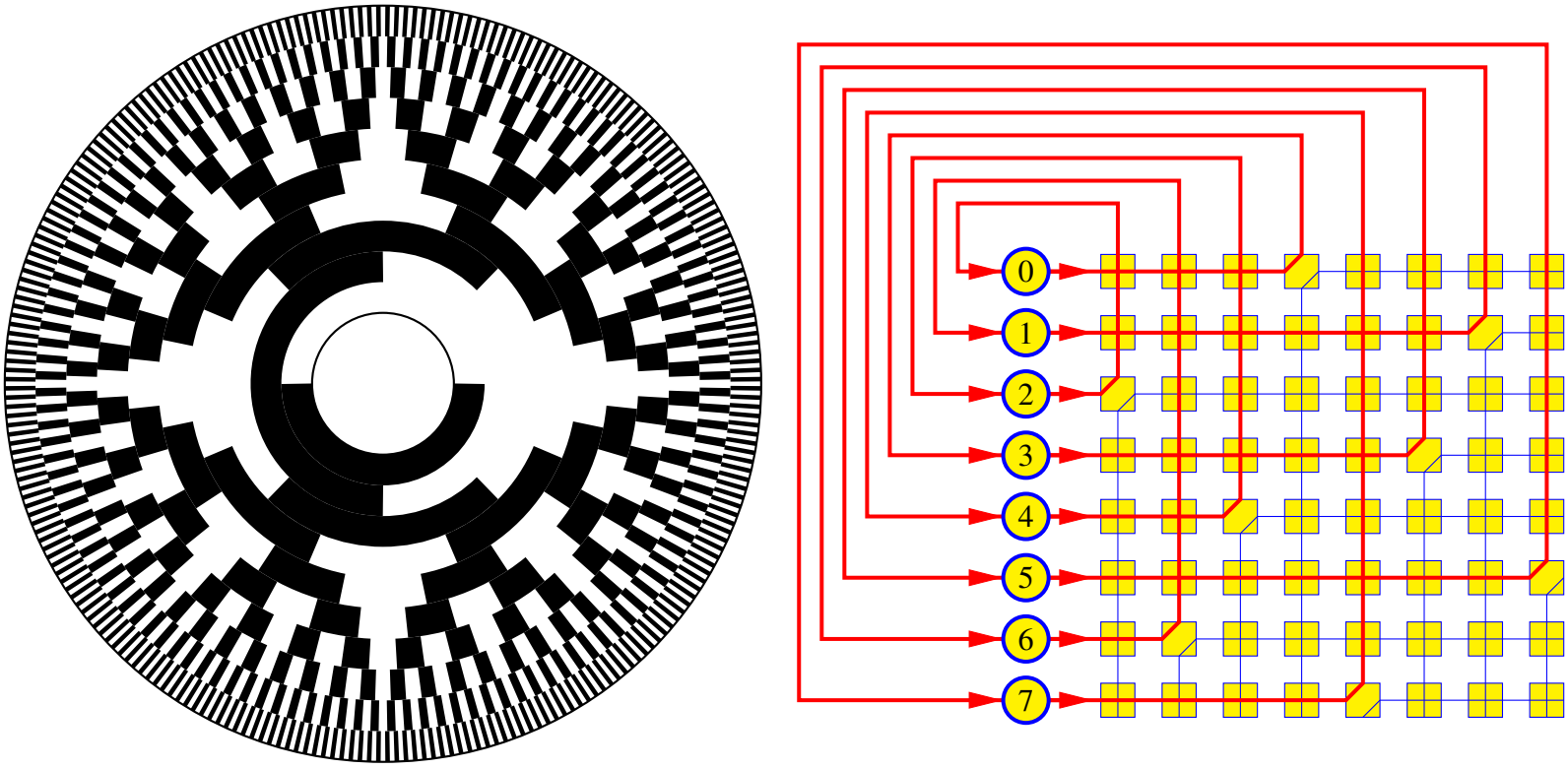
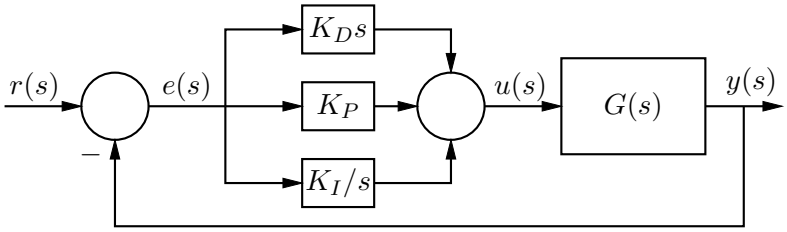
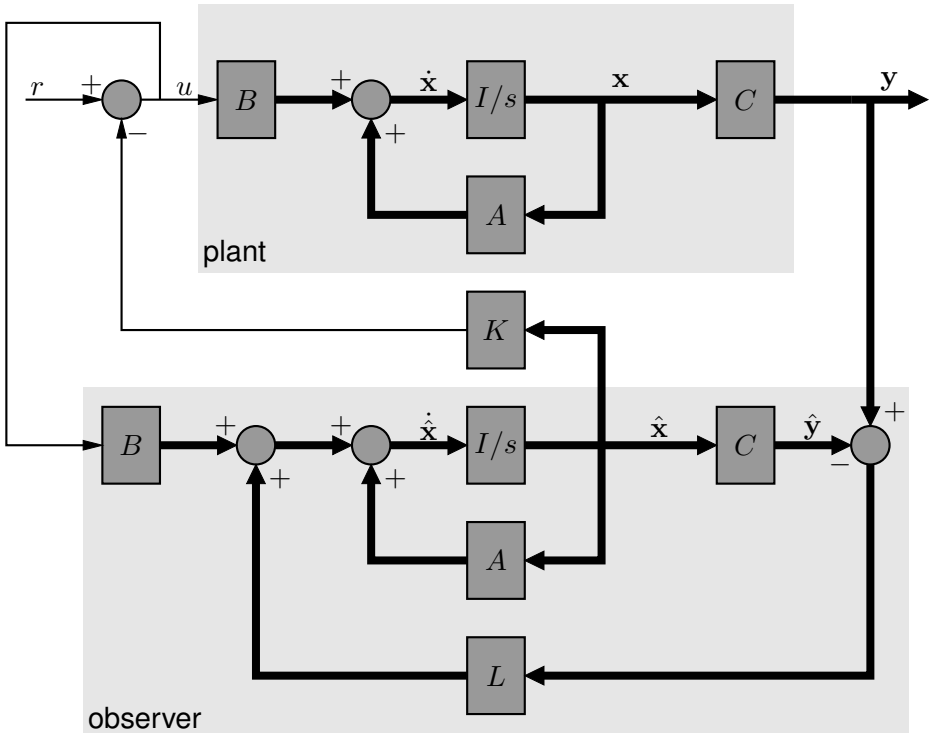


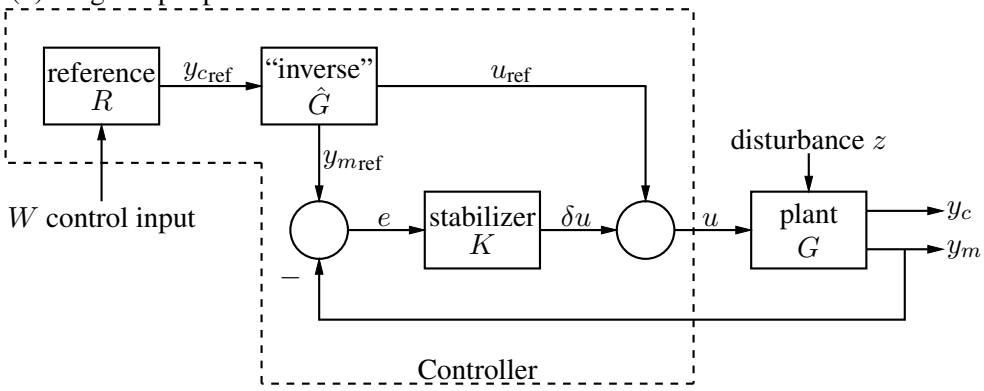
Figure 83: The power of looping and branching: Gray code 10-bit encoder disk pattern and a crossbar switch `[GrayCode.m4]`.



(a) PID control



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



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

Figure 84: Control-system block diagrams `[control.m4]`.

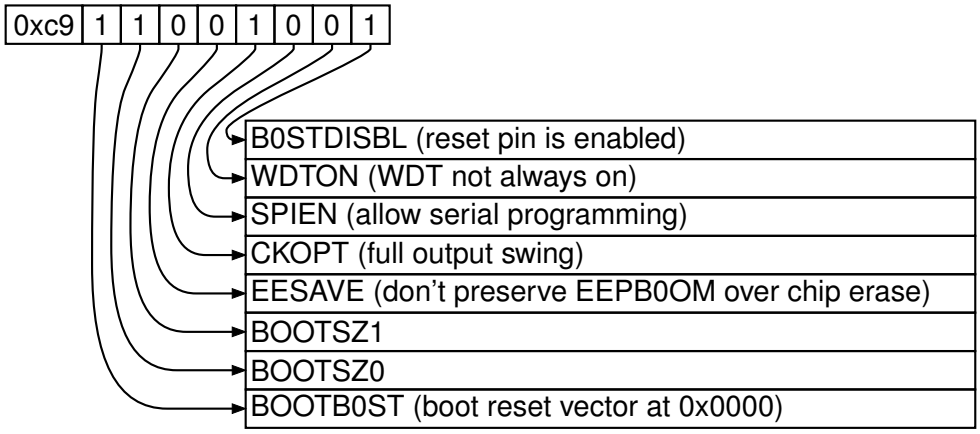


Figure 85: Elementary splines `[Byte.m4]`.

Figure 86: A customizable seven-segment display showing the numbered segments, a custom shape, and the numerals from 0 to 9 `[Sevensegment.m4]`.

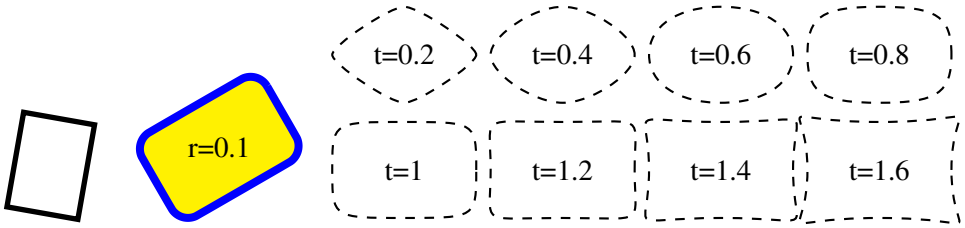


Figure 87: The macro `rotbox(`*wid,ht,type*`,[r|t=`*val*`])` draws a box in the current direction `[Rotbox.m4]`.

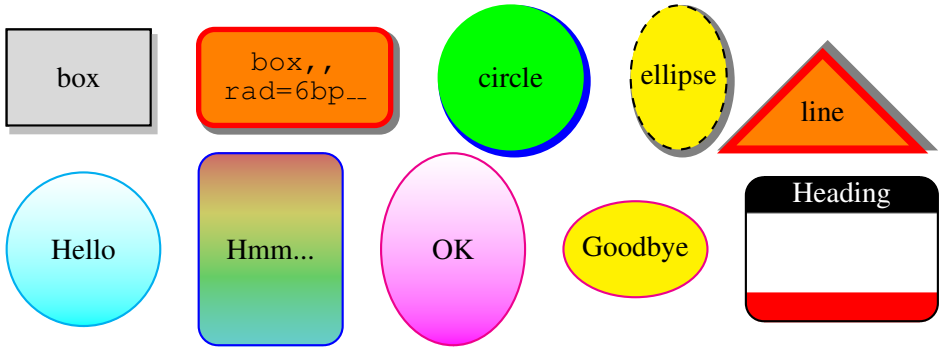


Figure 88: Embellishments: the top row illustrates `shadowed(box|circle|ellipse|line,[at` *position*`],`*keys*`)` and the second row `ColoredV(box|circle|ellipse,(`*r,g,b*`)|((`*colorseq*`)),`*attributes*`)` `[Shadowed.m4]`.

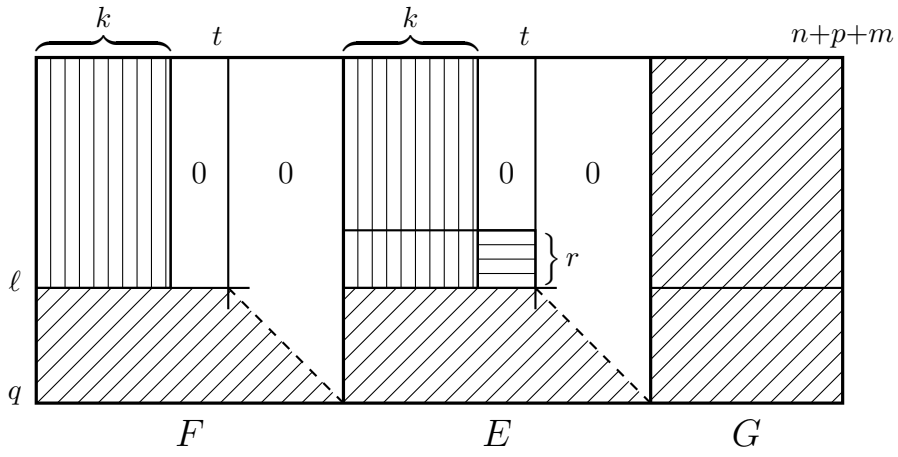


Figure 89: Crosshatching `[ex06.m4]`.

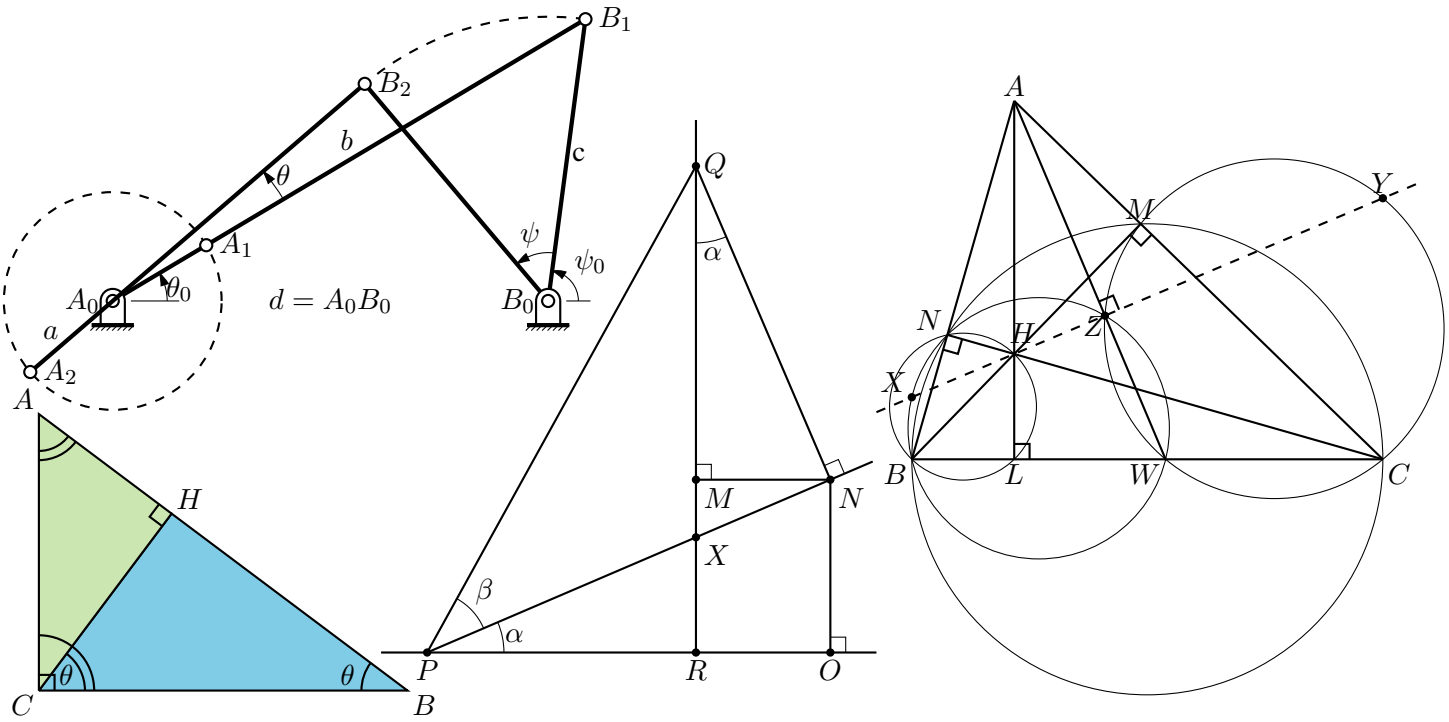


Figure 90: Some geometrical constructions [Geometry.m4].

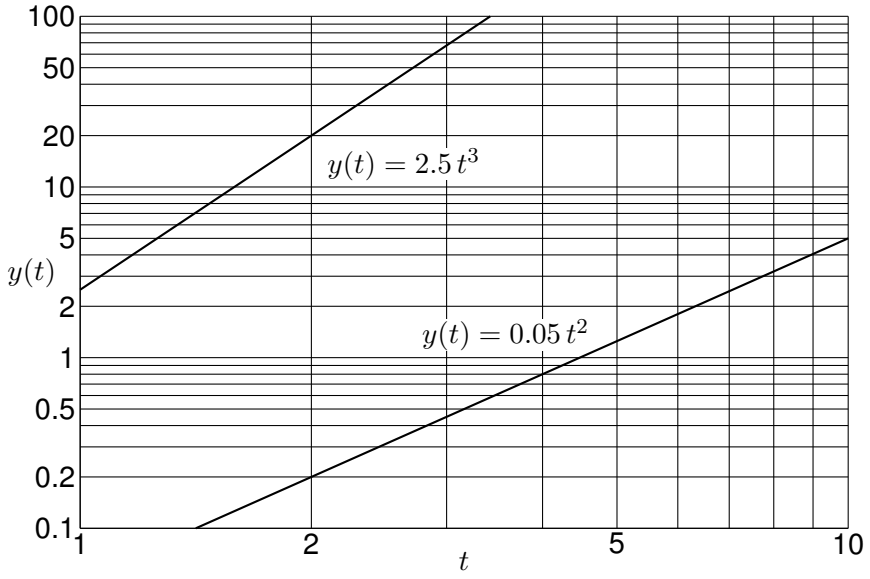


Figure 91: A graph drawn using the pic language [Loglog.m4].

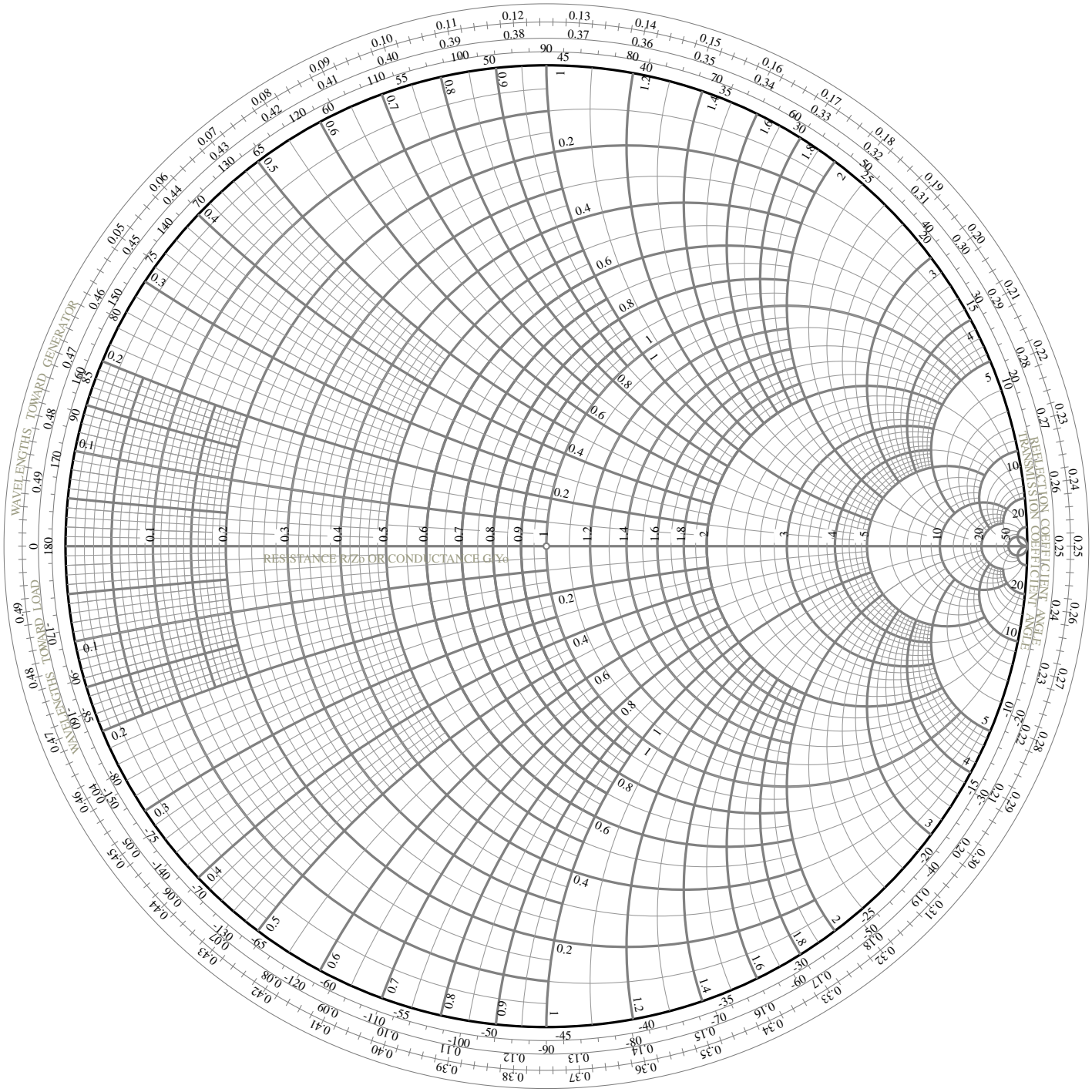
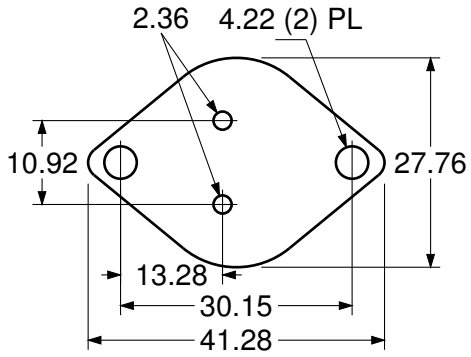
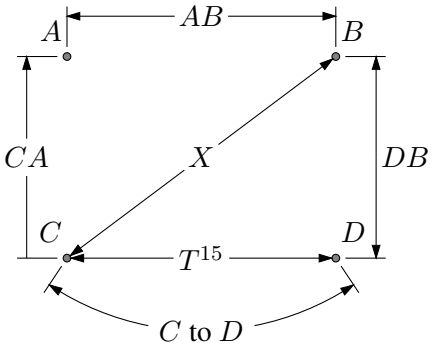
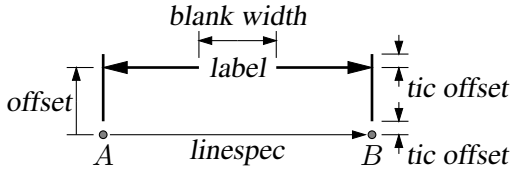


Figure 92: A Smith chart `[Smithlchart.m4]`.






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




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

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

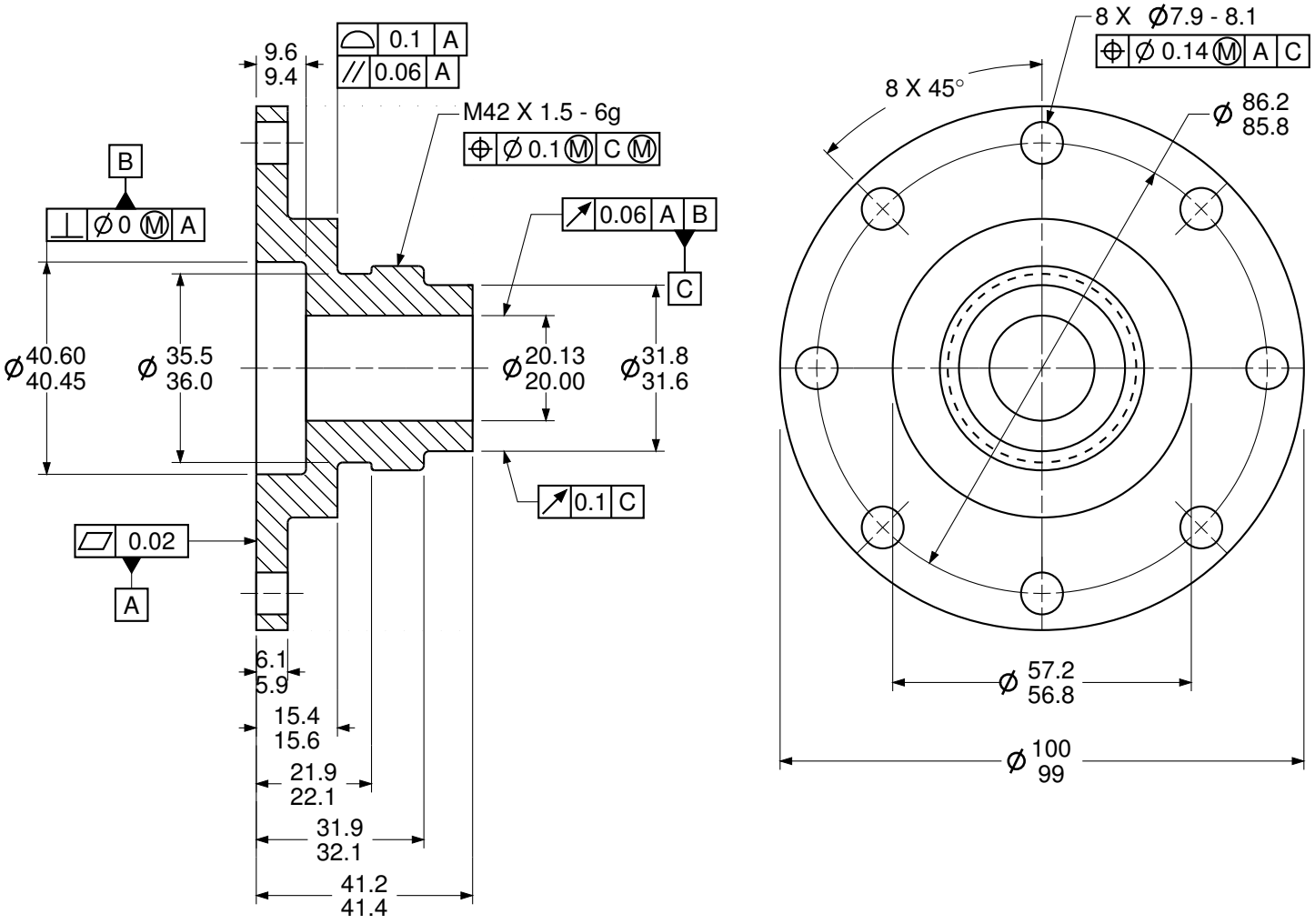


Figure 94: Dimensioning with tolerances `[Plate.m4]`.

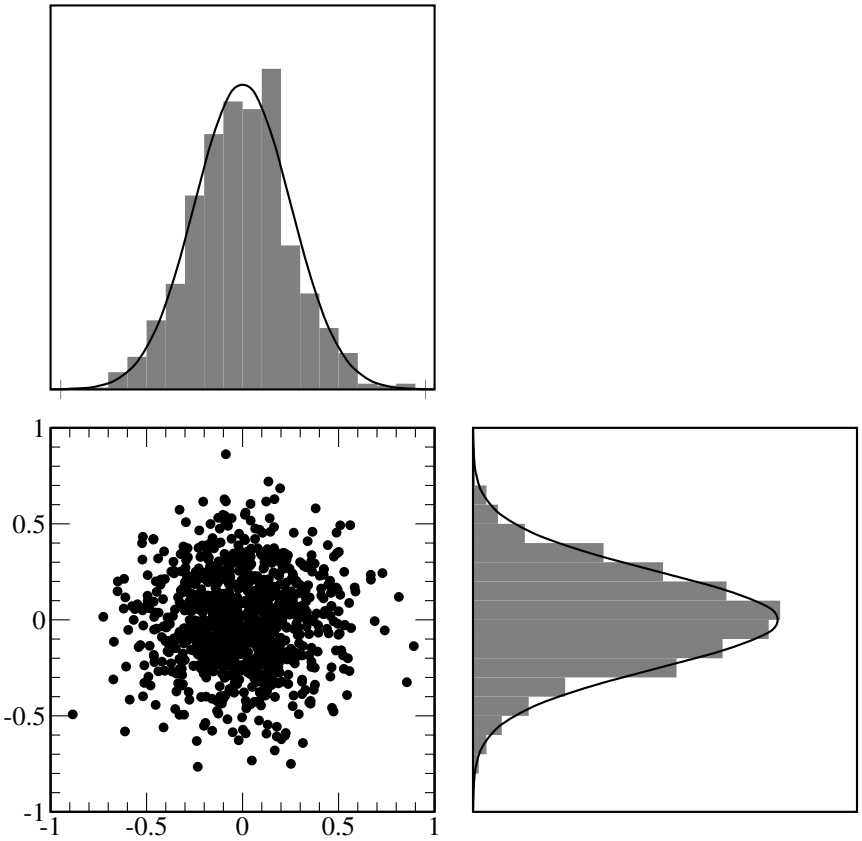


Figure 95: Testing random number generation using dpic macro `randn(`*array name, n, mean, std dev*`)` which calls pic built-in `rand() [random.m4]`.

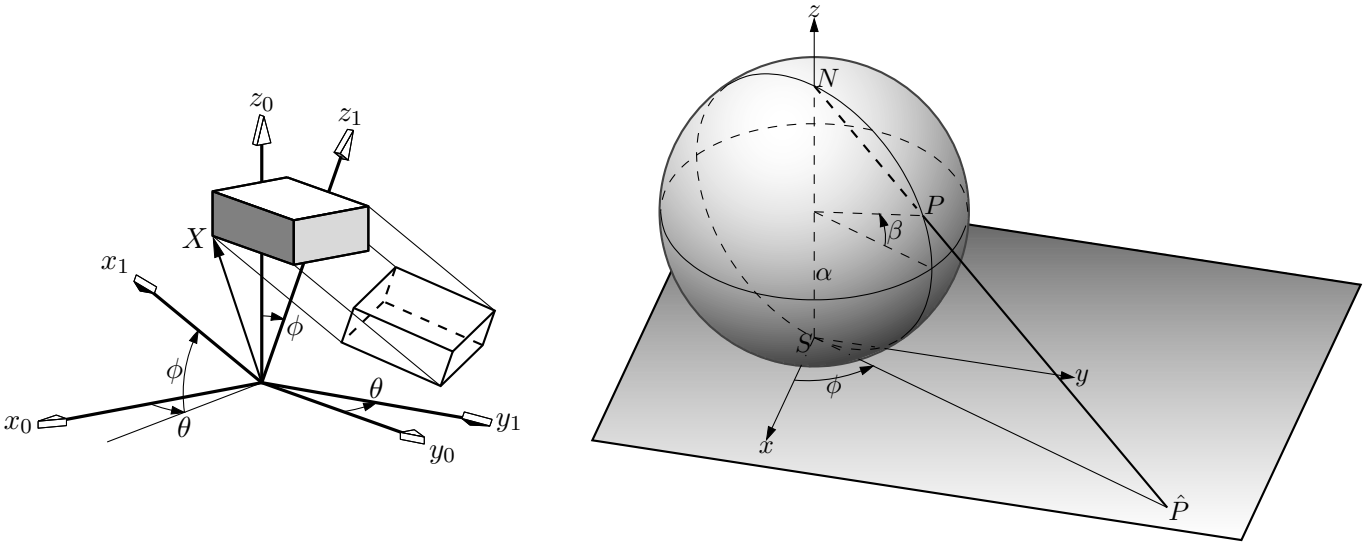


Figure 96: Test of `project` and other `lib3D` macros, showing the projection of a solid onto the y_1, z_1 plane by sighting along the x_1 axis. `[exp.m4]`.

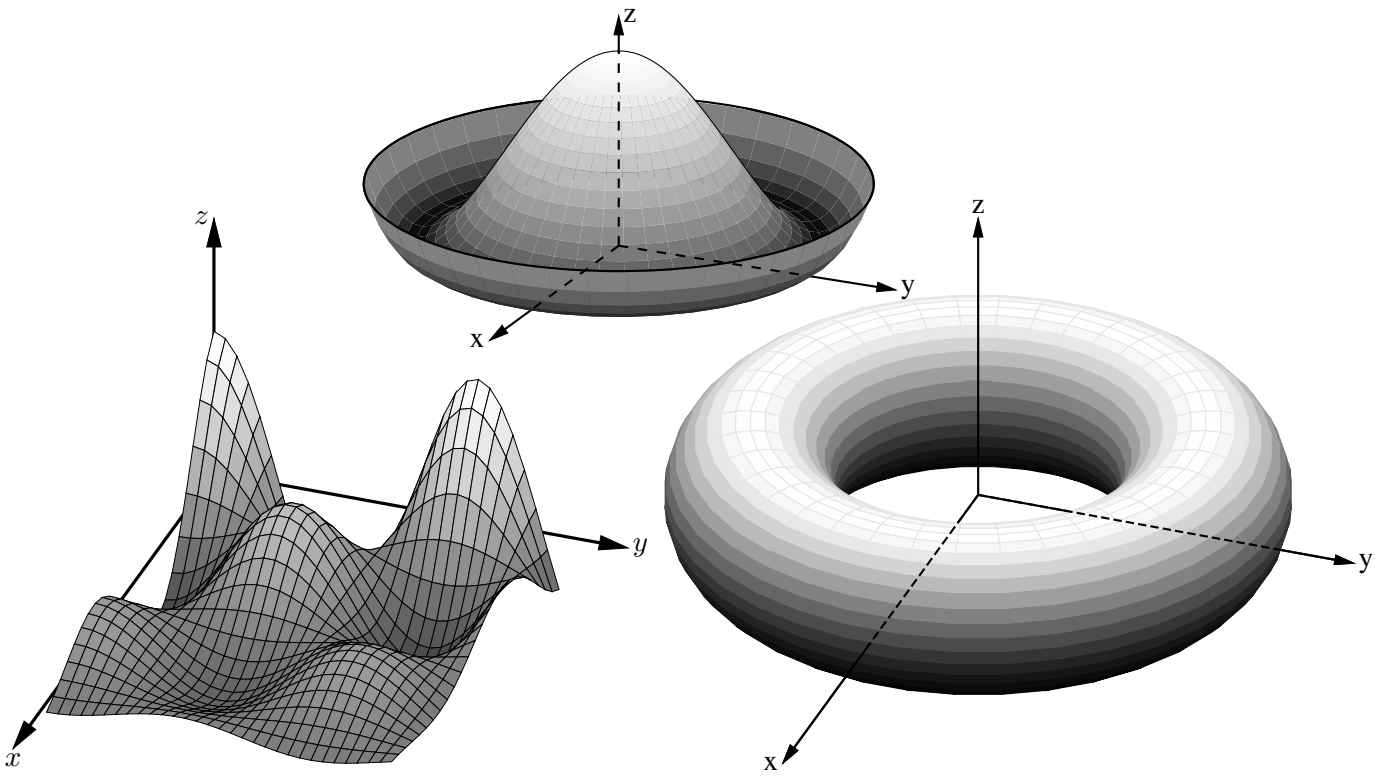


Figure 97: Plotting surfaces using gray scales `[graysurf.m4]`.

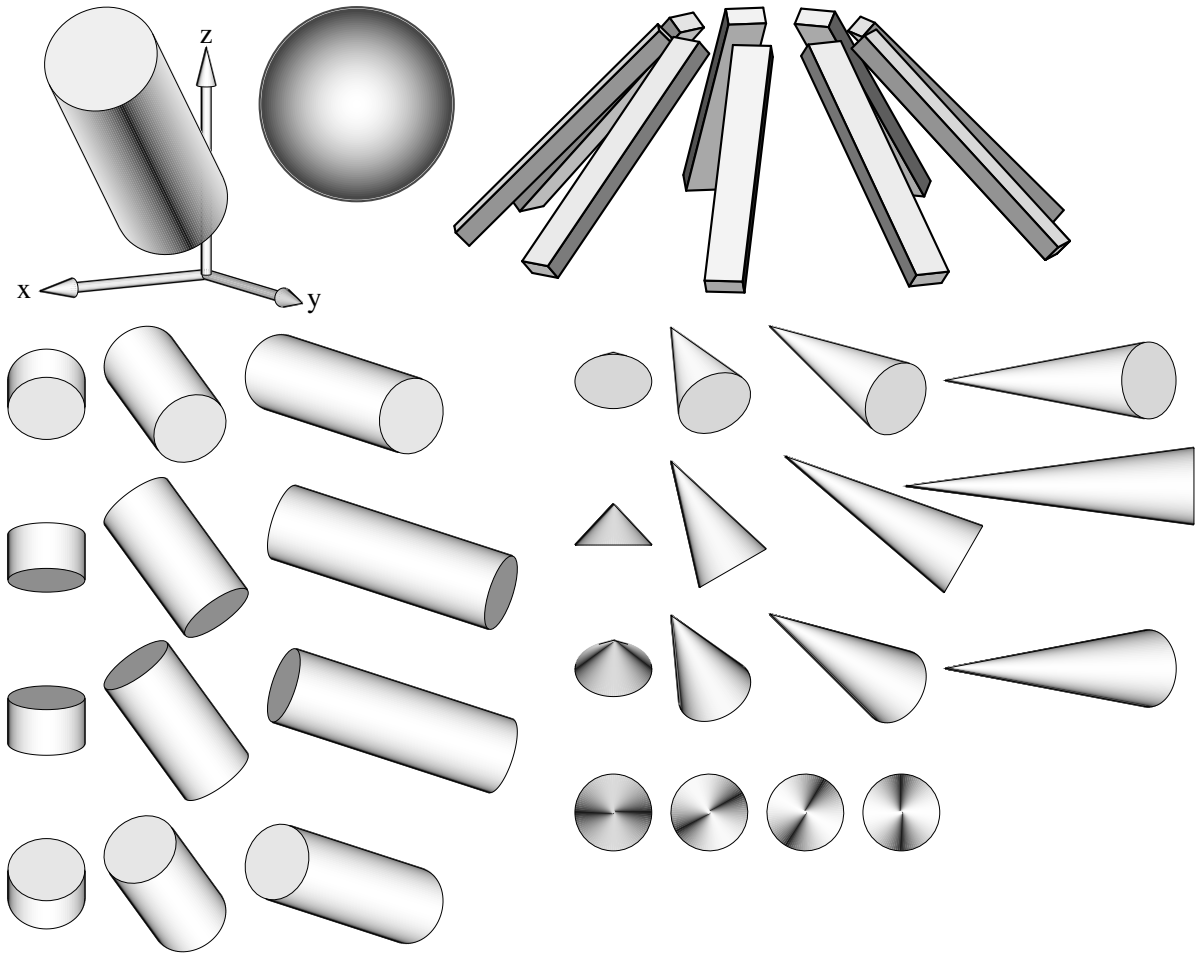


Figure 98: Basic shapes `[shapes.m4]`.

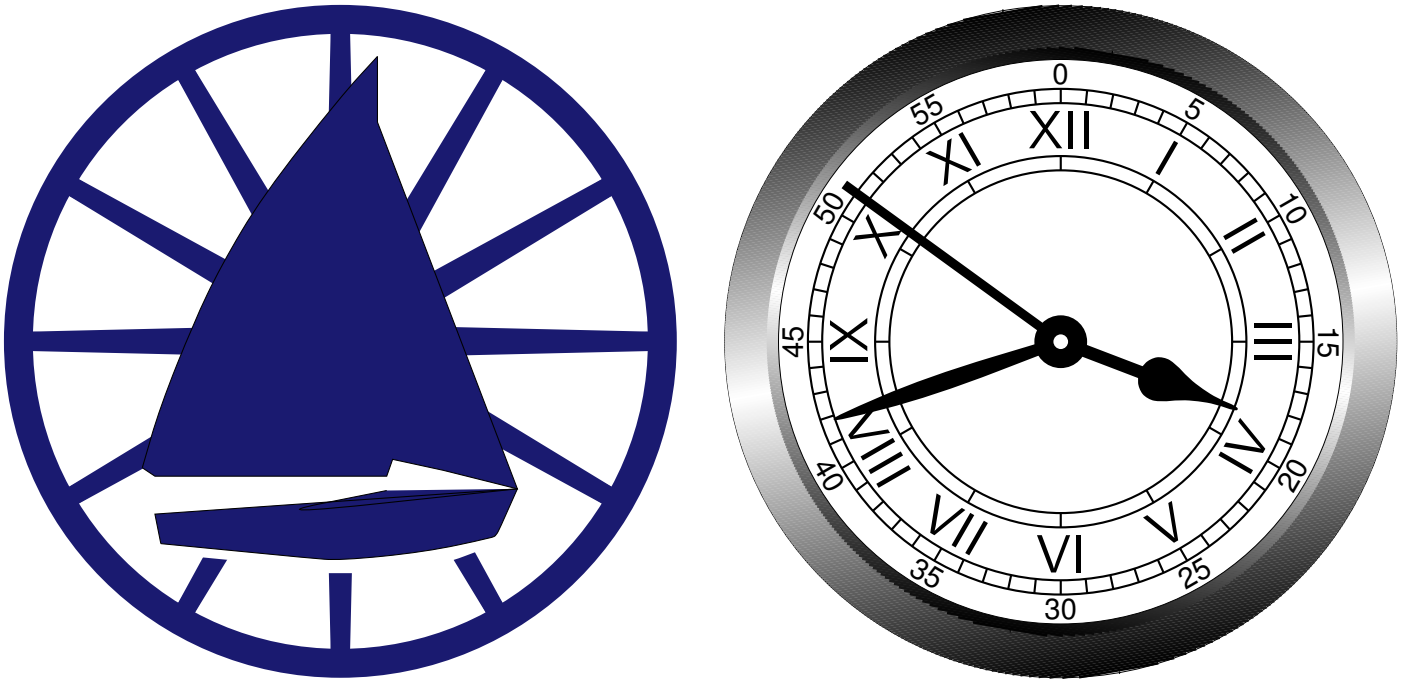


Figure 99: Conestoga Sailing Club (illustrating the filling of arbitrary shapes) and an antique clock face with shading and rotated text `[csc.m4]`.

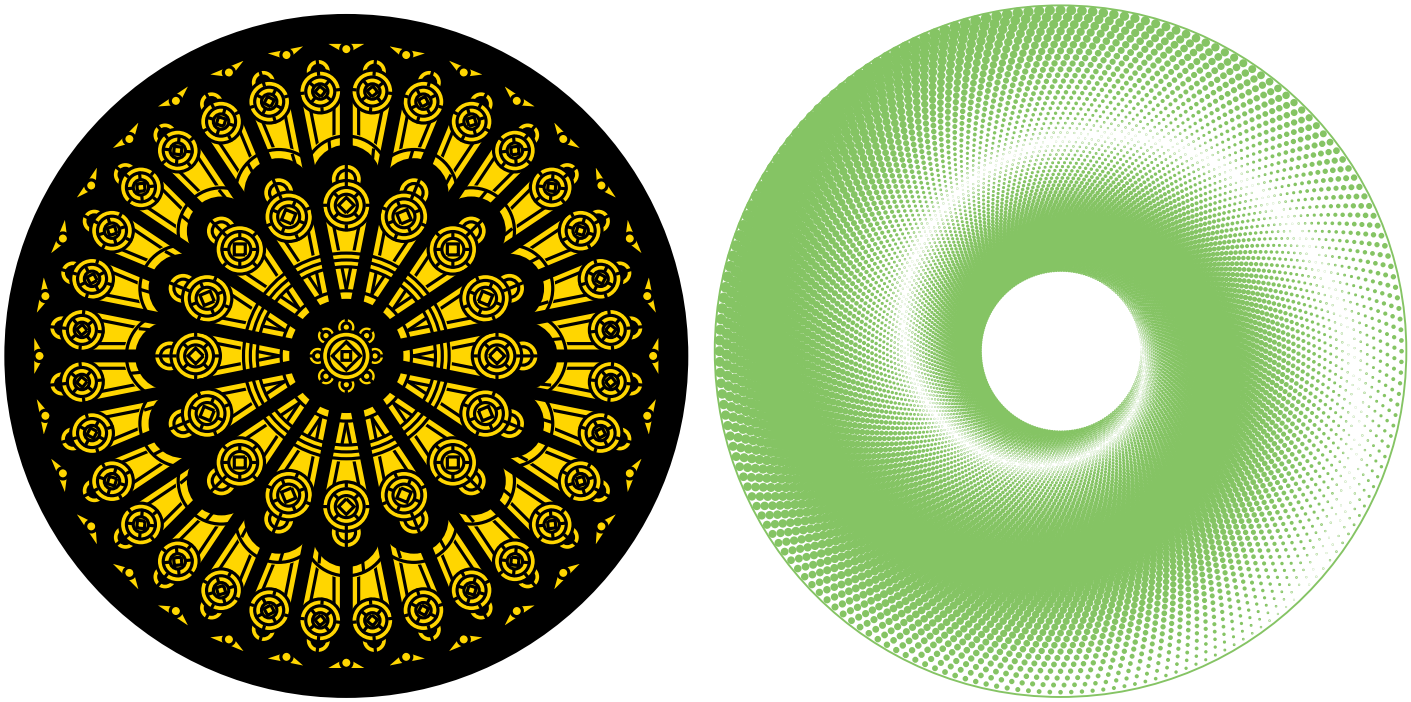


Figure 100: The left object, used for testing `dipic,` is redrawn from a detail of the set design for the musical *Dracula.* This consumes much LaTeX main memory but can be produced directly as pdf using `dpic -d`, as svg using `dpic -v`, or as postscript using `dpic -r` since no text formatting is required.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

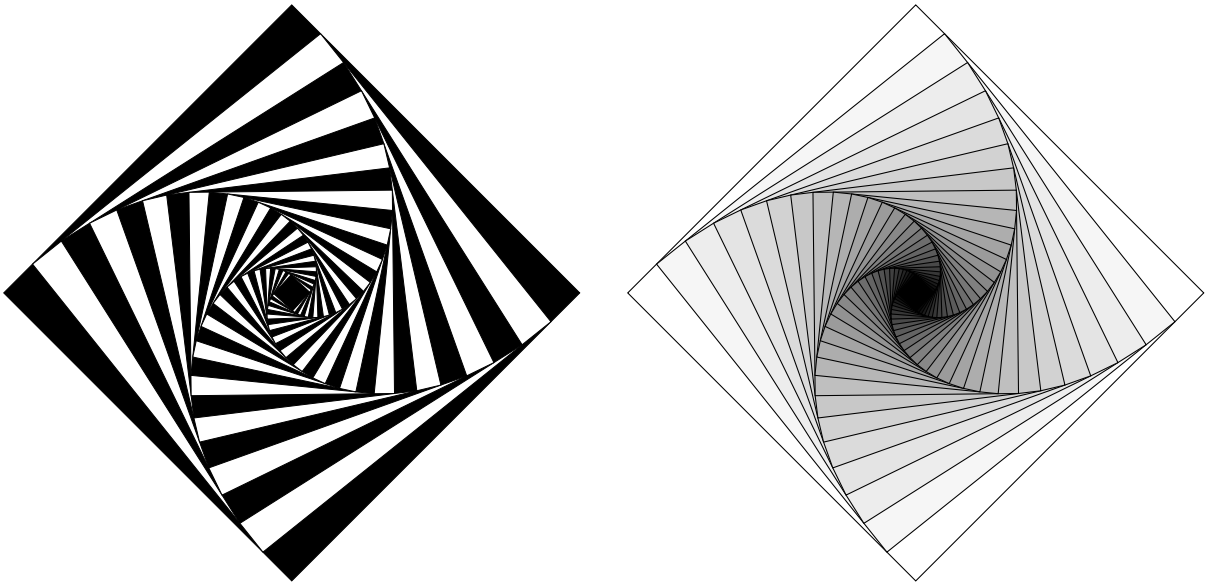


Figure 101: Variations on M. Goossens, S. Rahtz, and F. Mittelbach, *The LaTeX Graphics Companion,* Addison-Wesley 1997, pp. 57-58 `[diamond.m4]`.

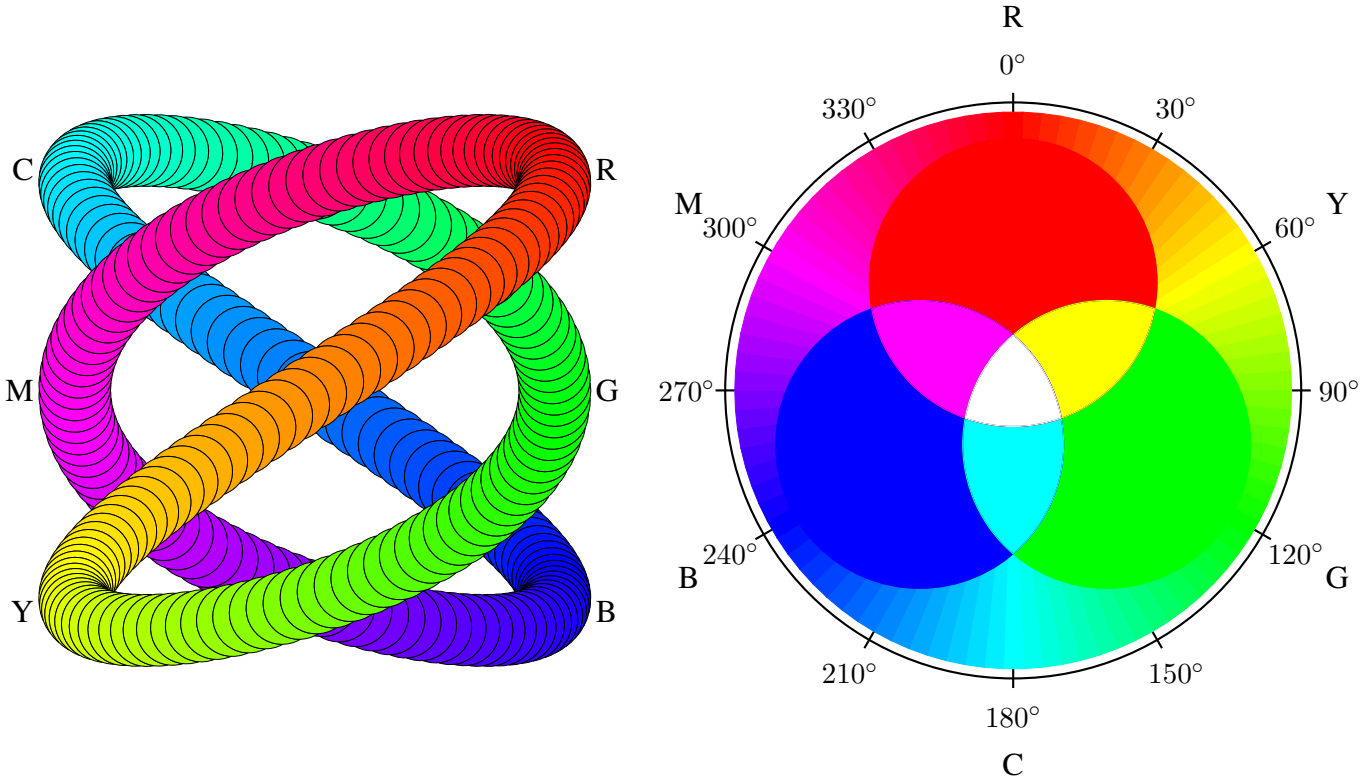


Figure 102: An exercise in calculating RGB colours `[worm.m4]`.

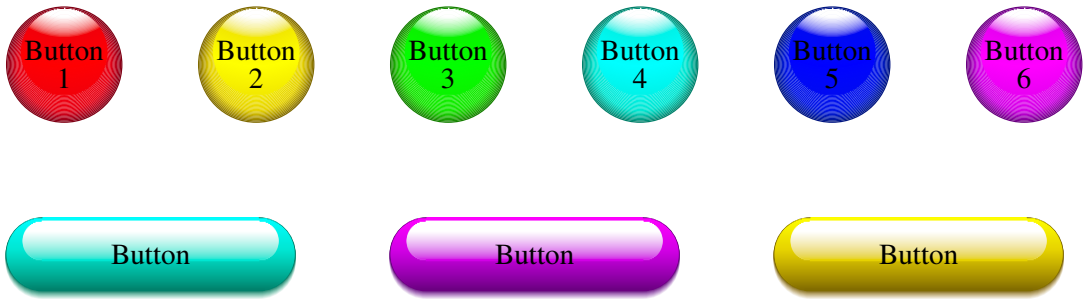


Figure 103: Shading in color `[Buttons.m4]`.

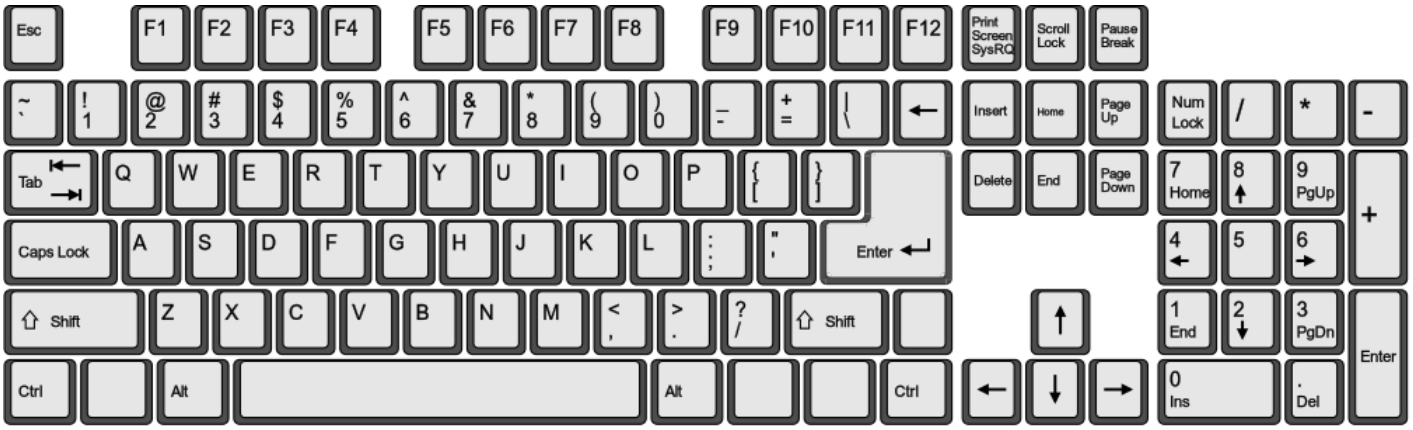


Figure 104: This diagram has been produced as svg with dpic -v (then converted to pdf for inclusion in examples.pdf) `[keyboard.m4]`.

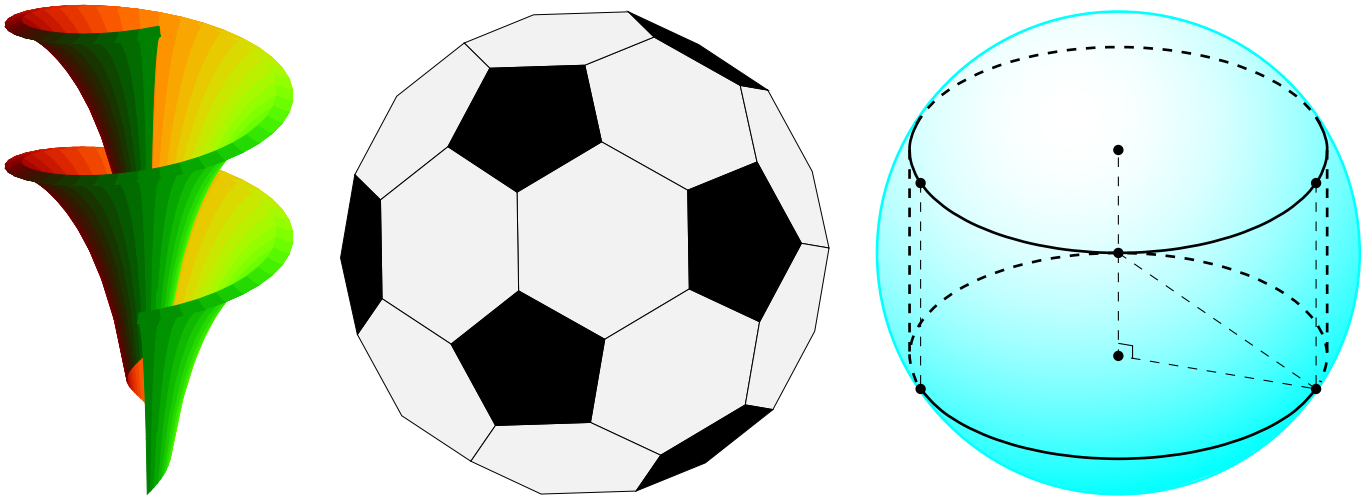


Figure 105: Dini surface, an icosahedron, and a sphere with inscribed cylinder `[Dini.m4]`.

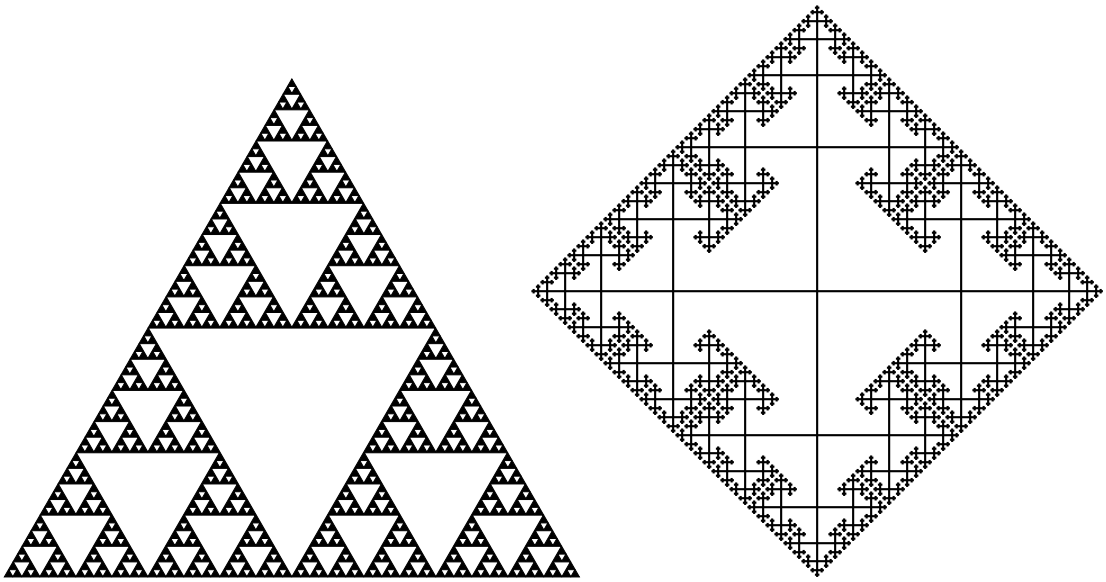


Figure 106: The Sierpinski triangle and a Cayley graph: tests of pic macro recursion `[Sierpinski.m4]`.

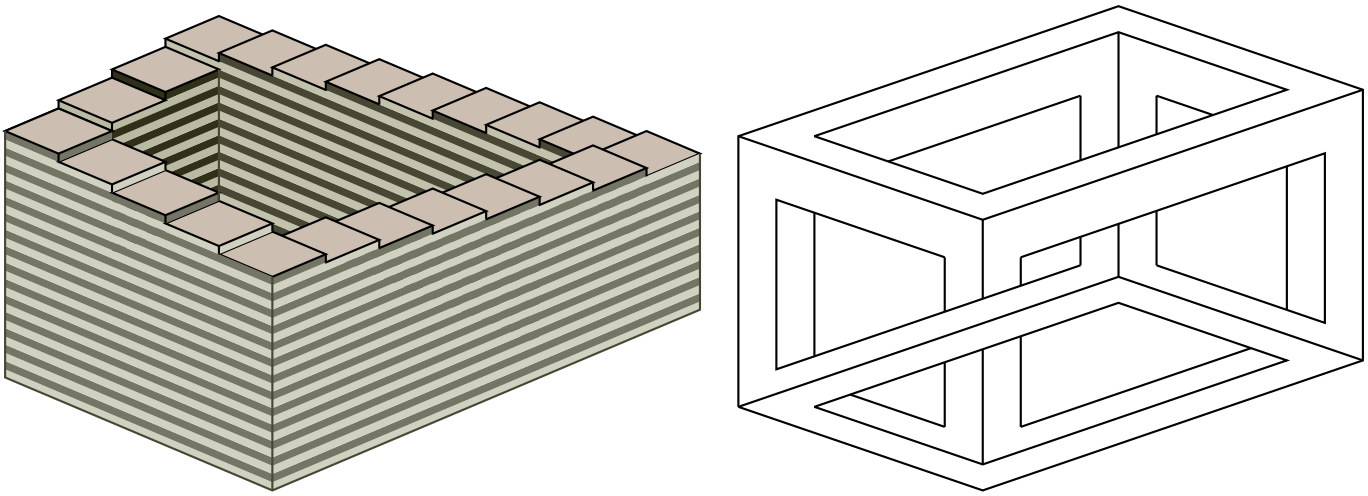


Figure 107: Penrose stairs and an Escher-like object `[Escher.m4]`.

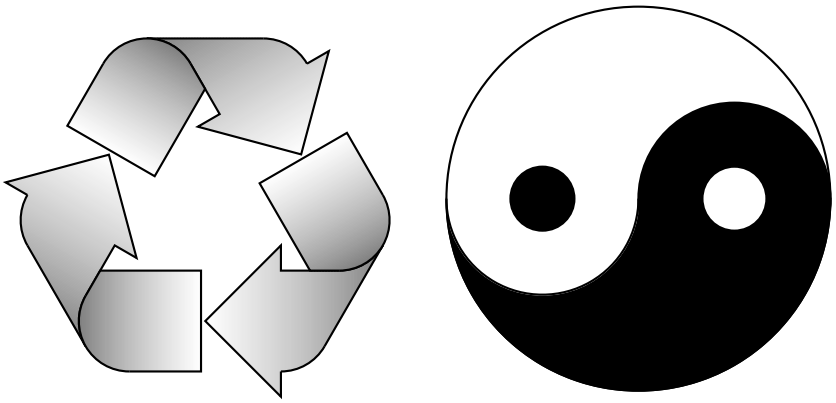


Figure 108: Modest repetition and partial fill `[recycle.m4]`.

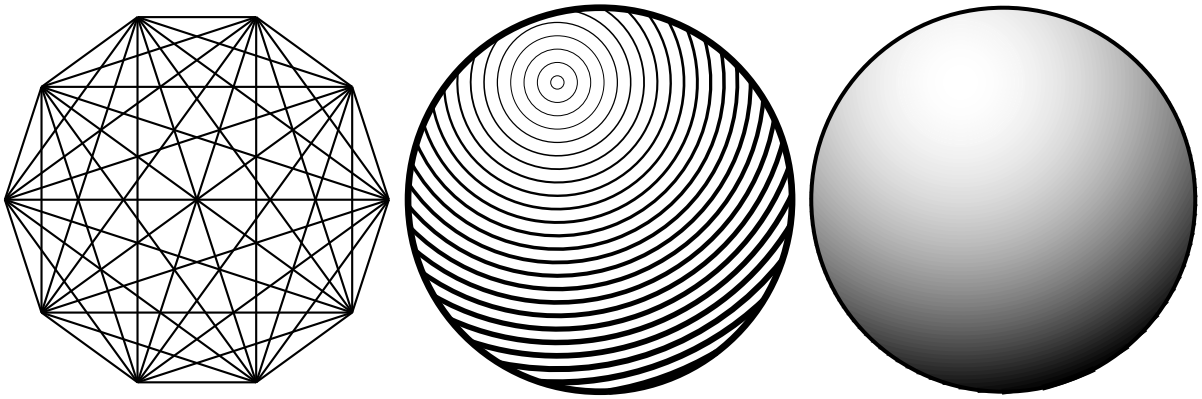


Figure 109: Simple diagrams that are easily drawn by looping `[ex15.m4]`.

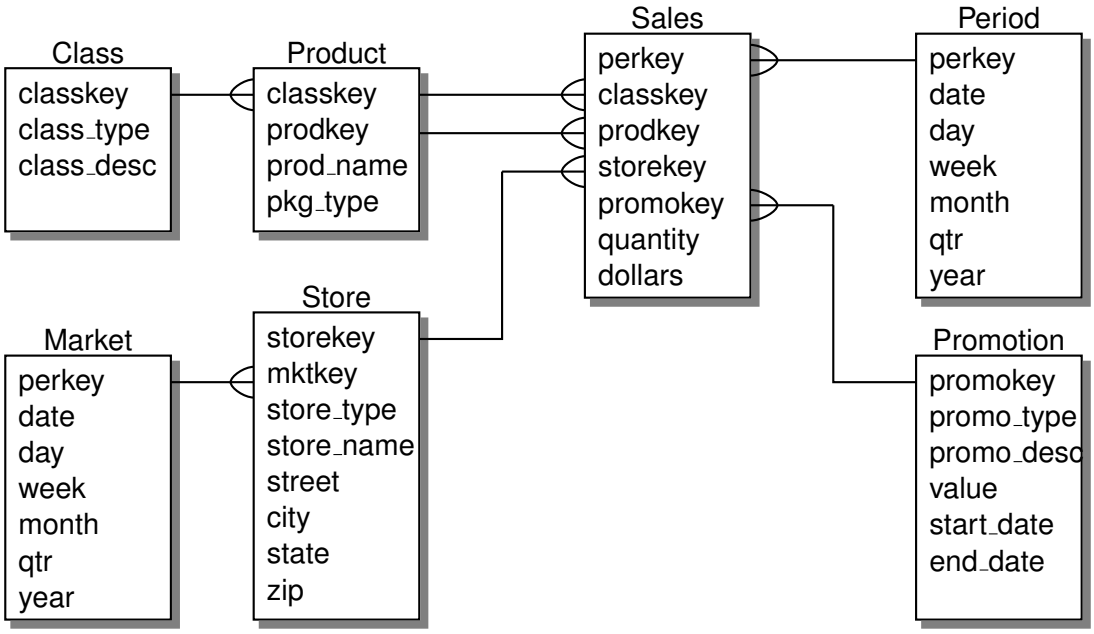


Figure 110: Illustrating `shadebox` and a custom crowfoot line termination `[Crow.m4]`.

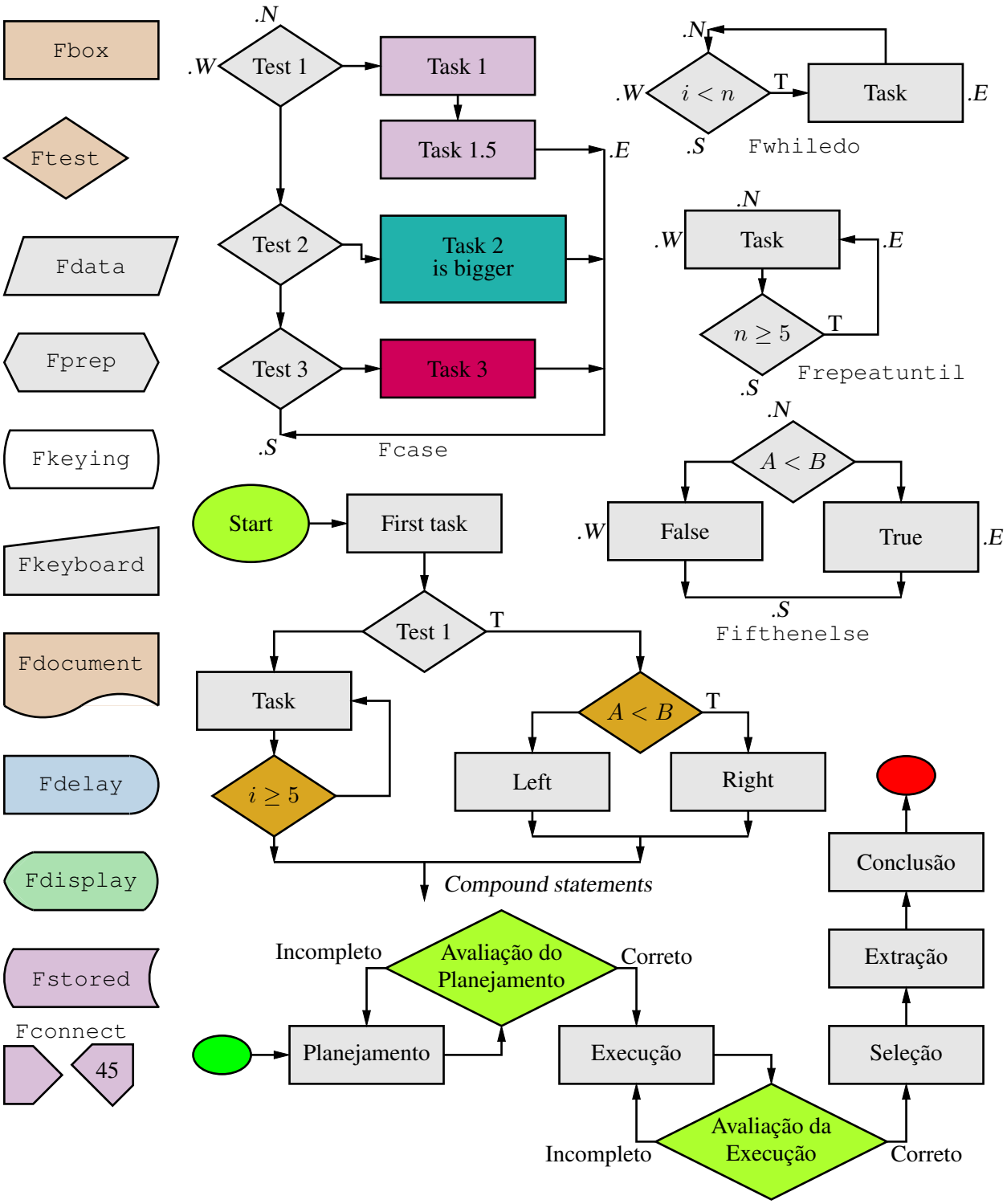


Figure 111: A flowchart sampler `[Flow.m4]`.

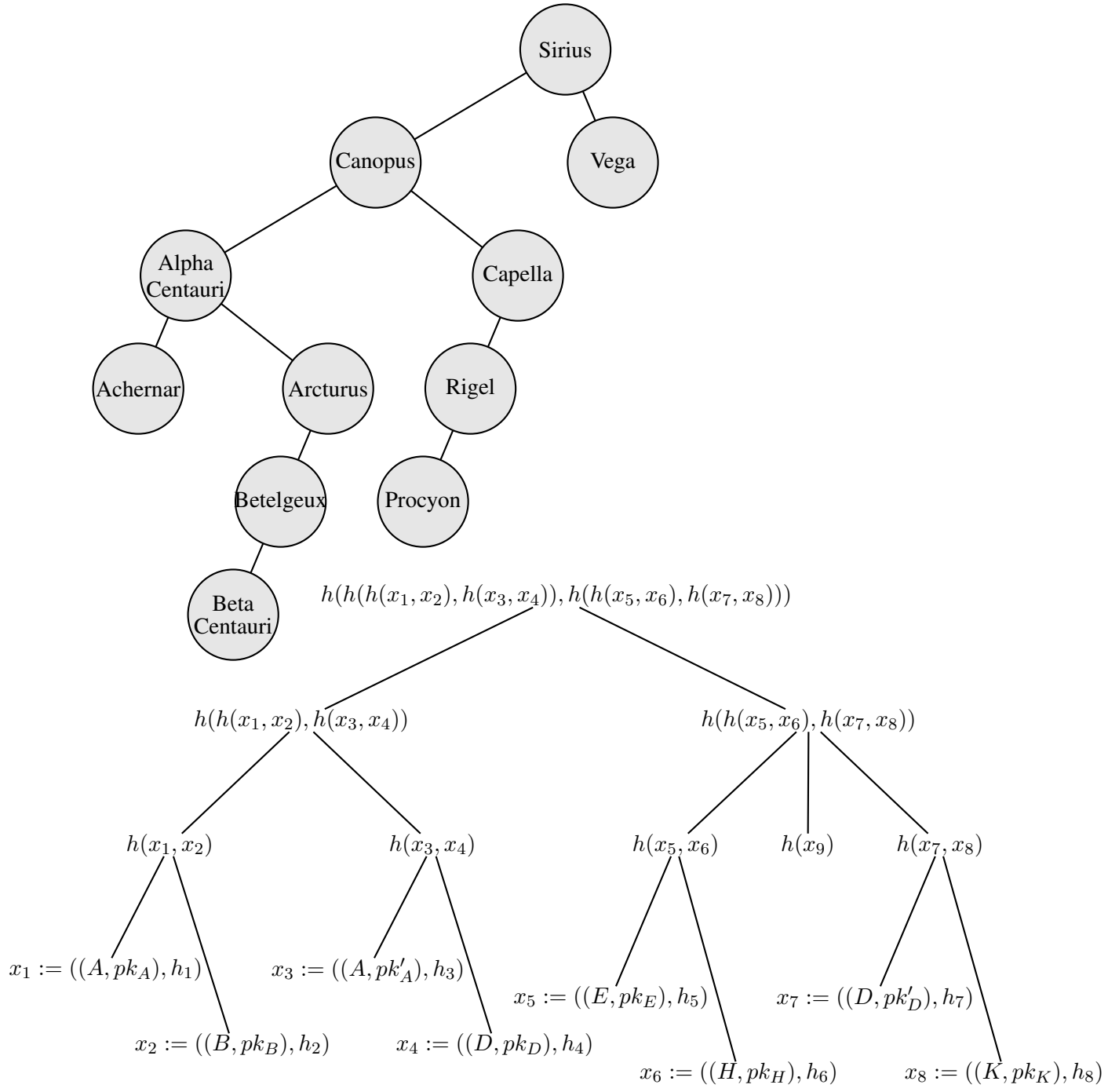


Figure 112: Trees `[Btree.m4]`.

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