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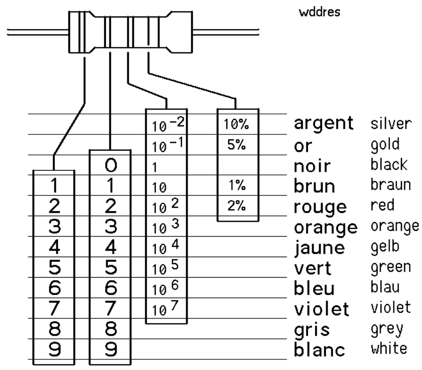
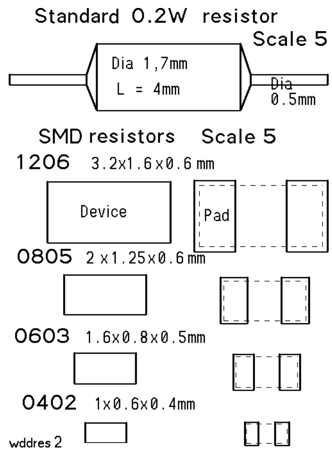
General doc - Electronic components

Resistors



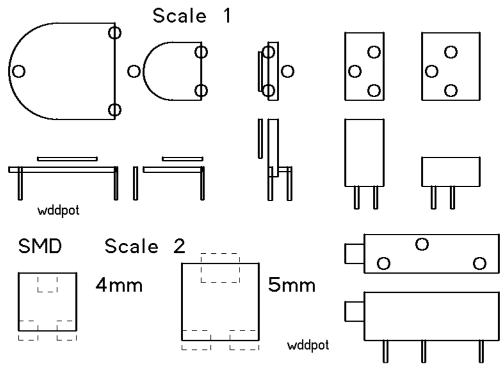
Resistors exist in many sizes. Color coding is used on cylindrical resistors. Resistors value follows a logarithmic E-serie: E6 is 10-15-22-33-47-68. The E3 serie (10-22-47) is frequently sufficiant in the digital world. If you need E12 or E24 intermediate values, it means you are applying too precise computations on always imprecise sensor data; use a potentiometer-trimmer to allow adjustements within the prototype.



On SMD devices and resistor networks (resnets), a 22 kOhm resistor is labeled 223, which means 22 x 10^3 Ohm. The third digit is the power of 10. Another labeling is r22 for 0.22 Ohm, 2r2 for 2.2 Ohm, 22r for 22 Ohm, 2k2 for 2.2 kOhm, 2M2 for 2.2 MOhm. Precision is 5 or 10%. Temperature sensitivity is usually not a problem in robot interfaces.

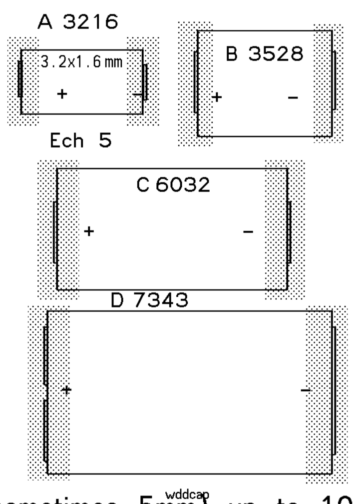
Miniature SMD resistors exists in four sizes. The preferred one is 0805, that is 0.08 inch by 0.05 inch, about 2 by 1,2 mm, 0.6 mm thick.

Potentiometers (trimmers)



In the past, potentiometers were fixed on a chassis, with wires toward the PC board. It is more reliable to fix them directly on a PC board. Trimmers replace resistors when the value has to be adjusted. Pot exists with open or closed frame. Reliability is good with all models. Plastic coating is preferable to carbon track if the rotation movement is frequent. One avoid as much as possible the use of pots. Software controlled resistance permits a dynamic adjustment.

Capacitors



Capacitors are based on thin foils (low capacity but high frequency response) or polarized electrolytic (high capacity, frequency response limited to 1 kHz). The capacity value indication, if any, is frequently difficult to read or understand. One should buy only correctly labeled capacitors. Capacitance value is written in pF: 223 is 22×10^3 pF = 22 nF; 106 is 10×10^6 pF = 10 μF. Another labeling uses p, n, u for pico, nano, micro. E.g. 22n is 22 nF. 2p2 is 2.2 pF, 2n2 2.2 nF, 2u2 2.2 microfarad.

SMD electrolithic capacitors have a black mark on the plus side, and sometimes a small + sign next to the plus side.

0.95

Normal capacitors have 2 pins with a spacing of 2.5 mm (sometimes 5mm) up to 10 microfarad. SMD capacitors starts with the same sizes as SMD resistors: 0402, 0603, 0805, 1206, 1210, 1812 and larger. Tental capacitors are used between 1 and 50 microfarads. Power supply decoupling needs 1000 microfarad capacitors or more, depending the current. A too large value on an interface board may short-circuit the processor supply when the connection is established.

A 100 μF next to the power input wires is recommended. A 100 nF decoupling capacitor is required next to the IC having to switch many lines in the same time, or next to circuits toggled at high frequency.

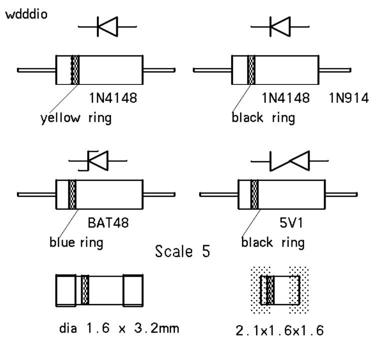
Supercaps are used as a secondary power supply, e.g. to keep the voltage while a battery is changed. Their resistance is low, and they can provide current surges on a small battery with a high internal resistance. They are expensive: about 10 CHF for 1 Farad capacity at 5V (size about 2 cubic centimeters).

Inductors

Selfs and transformers are mostly used within power supplies. They can be wired on a ring to get the correct inductance and resistance. The two important parameters are induction (milliHenry) and maximum current (that is resistance). Simple coils are frequently used to cut high frequency harmonics that may perturbate radio and TV receptors.

Diodes and Zener

Diodes are used as voltage limiters. For currents up to 50 mA, two models are widely used: 1N4148 with a voltage drop of 0.7 V and BAT48 with 0.3V only. Higher current are required for rectifying diodes. 1N4001 to 1N4004, according to the maximum voltage, are well known.

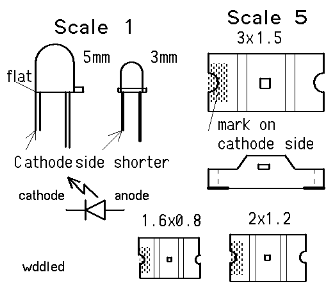


Zener diodes have a reverse voltage with a sharp characteristic for the marked voltage. They should not be used as voltage regulator, except for polarization (one milliamp current max).

Voltage references are used with A/D converters. They act as a Zener with a sharper resistance edge for small currents, more stable with tempreature.

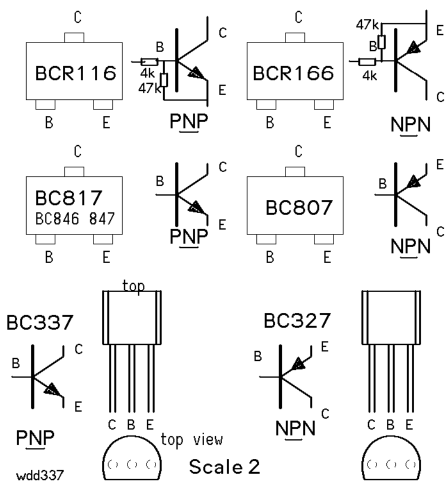
LEDs

Light emitting diodes are visible (red, gree, yellow, blue) or infrared. Deep red have the better efficiency. A limiting current resistor is always required. 1k is typical for applications inside a building. Voltage drop is 1.7 Volts . Two diodes can be connectd in series when one needs to double the light energy for the same electrical power (resistor value has to be recalculated).



Infrared is preferable for a better match with photosensors.

Transistors

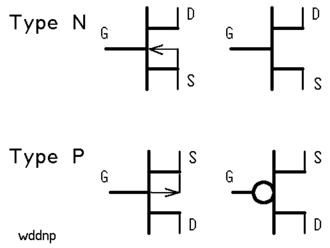


Transistors are only considered here as switching devices. They should be saturated or open.

Bipolar transistors are controlled by a current. Gain is greater than 100, that is 1 mA as a base current can switch a 100 mA collector current.

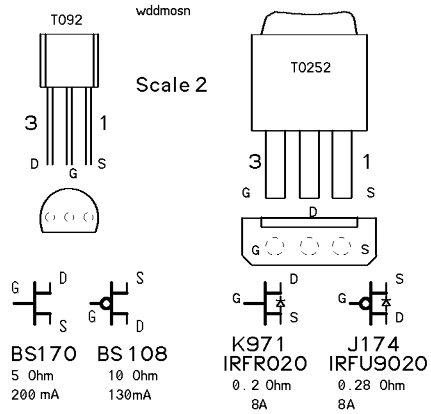
Mos transistors do not need a resistor on the gate. The input resistance is very high, so they must not be left open (use a pull-up or pull-down resistor if not connected to a well defined signal). Saturation requries a 2.5 to 4 Volts minimum gate to source voltage. Saturation of a P-transistors require a on the gate a minimum of 3.5 to 5V less than the source.

1 A P-transistor are not so good as for N-transistors (we are mostly concerned about internal resistance). N- and P-Mos transistors have two symbols. We will use the simplest, associated with the mnemonic trick "P channel is controlled by a voltage active low, that is an inverted variable symbolized by an inverting circle; P has a loop corresponding to the inverting circle drawn on the gate".

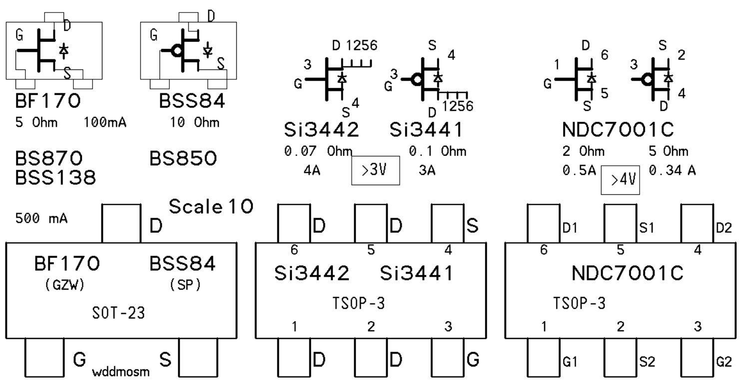


Mos transistors used for switching inductive loads include protection diodes. They hence can control an inductive load. The internal resistance and the heatsink is related to power dissipation, that is to the maximum acceptable current.

Mos transistors exist in many packages. The TO-92 package is convenient for small current, e.g. when a LED must be controlled. The TO-252 package dissipates more power; thermal radiator is optional. TO-251 package (not shown in figure) just has short bent legs, in order to mount the transistor on the surface of the PC board. A larger copper area may help for the power dissipation.

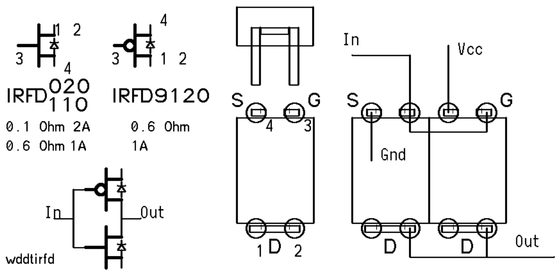


Miniature Mos transistors have quite impressive characteristics. Resistance is low and heat dissipation is good. N-Mos transistors are saturated by a 2.5-4V voltage. N-Mos need -3 to -4V relative to the source. Si3442/3442 can drive motors up to 1A, minimum 4 Volts. The NDC70001C is limited to 50 mA at 5V minimum.



One problem of SMD transistors is they are marked usially with code numbers. They are designed for mass production automatic insertion machine: the reel is well marked, not the transistors.

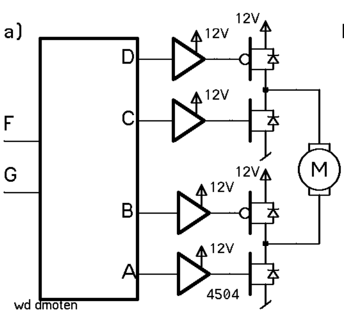
The IRFD Mos transistors with their 4-pin DIL package should not be used for new designs. Several are available by André Guignard LAP; they are easy to implement for prototyping on DIL sockets.



H-Bridges

A H-bridge includes 4 transistors in oder to control the current flow in one direction or the other. Previous figure with the IRFD transistor pairs is a half-bridge. The important parameters for a bridge are the minimum voltage, the max current and the internal resistor, which is usually not as good on the high side, which uses P-Mos transistors.

a)



b)

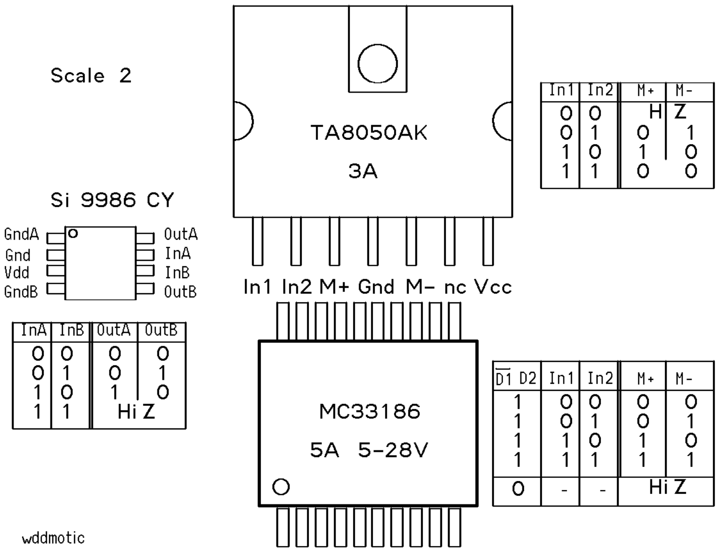
G	F	DCBA	
0	0	1111	bloqué
0	1	0011	avance
1	0	1100	recule
1	1	1010	roue libre

L	E	S	DCBA	
0	0	-	1111	bloqué
-	1	0	0011	avance
-	1	1	1100	recule
1	0	-	1010	roue libre

ld8mo2

Some encoding logic is usually implemented, and temperature protection is included. One must be aware that a motor can be short-circuited, with the two N-transistors active, or open, with no transistor saturated. In the first case, it will stop quickly (this mode is required by speed control algorithms). In the second case, the voltage will increase and the protection diodes will break a little bit. An encoding which has the direction on one pin and the power on the other is preferable to one pin for left turns and the other for right turns.

Several commercial circuits exists. We are not interested here in the "more than 2 Amps, more than 12V bridges" The oldest is the LM296, which is reasonably efficient at 12V. A small efficient bridge is the Vishay-Temic Si9986CY in a 8-pin SMD package (3.8 to 13.2V, 1 A). This circuit needs some logic (a 74HC00) to be used with a microcontroller that has a single PWM output and a Direction control.



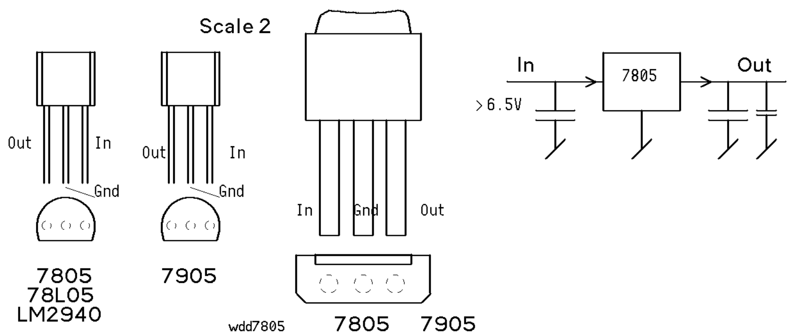
We recommend the MC33186 from Motorola. The TA8050AK from Toshiba is another solutions. The recent TPIC0107B and TPIC0108B have two different truth table. The Allegro 3959 measure the current. We do not recommend the old L273 and L298, which requires external diodes and have a poor internal resistance. Many bridges needs a voltage higher than 5V; most application uses 12V.

For the best control, the motor must be breaked (short circuit), but this increases significantly the power consumption. A PWM control with ON/High-Z state consumes much less current

The TLE 5208-6G is a serially controlled 6 half-bridges driver in a SO-28 package (0.6A, 5-12V).

Serial regulators

Serial regulators like the 7805 are well known and easy to get. The 78xx provides a voltage of xx. The 79xx are used for negative voltages (under disparition). A 7805 needs an input voltage of 6,5V or more. An adequate heatsink must be used according to the voltage drop and current.



Low drop-out regulators have a lower voltage drop. This means they can provide 5V from 5.6V, and heat less for voltage drop of e.g. 3V. A diode between the gnd pin and ground will change the output voltage by 0.6 V (1N914) or 0.3V (BAT42) if one need 5.6 or 5.3V.

Step-down regulators

Step-down regulators use a coil and are easy to implement with the available circuits. Recommended step-down regulators (1999 list):
LT4960 2A 8-20V in, 5-12V out, L+D+3C+2R
LT1076
LM2596-5 3A 7-40V in, 5V out, L+D+2C
LM2671-5 500mA 7-40V in, 5V out, L+D+3C

Step-up regulators

Step-up regulators are very convenient on battery-operated devices. They allow to use a 2-cell battery (2.4 to 3V) and generate 5V with a good efficiency. Step-up from 1.2 V is possible et a lower efficiency of 60%. Maxim offers a wide choice of DC/DC converters.

Op Amps

Too much to say!

A/D converters

A/D converters have parallel or serial outputs. Microcontrollers have no parallel bus and few I/O lines. Serial devices (2 lines I^2C, 3 or 4-lines SPI) exist in a wide choice, 8 to 14 bit resolution. Most of them are available as miniature serial devices, e.g (1999 lict):
ADCV0831 8-bit, 1-channel, 3-5V, CS, CK, MISO ssop6 (3x3mm!) 2.50
LTC1196 8-bit, 2 channels, 3-5V, CS, CK, MISO DIL8 so8 10.-
Max 1111 8-bit, 8 channels, 3-5V, CS, CK, MISO, MOSI DIL16, qsop16
ADS7841 12 bit, 4 channels, 3-5 V, CS, CK, MISO, MOSI DIL16, ssop16 15.-

D/A converters

Possible miniature serial inputs dvices:
Max538 12 bits, 1 channel, 5V, , CS, CK, MISO, MOSI DIL8, so8
LTC1454 12 bits, 2 channels, 3-5V, CS, CK, MISO, MOSI DIL16, so16
Parallel inputs
AD7393 10 bits, 1 channel, 3-5V