### Bill of Materials

**Microcontroller** *(optional): Arduino Uno or Netduino (1)*  
See page 2 for overviews. See [arduino.cc](http://arduino.cc) and [netduino.com](http://netduino.com) for specs, pinouts, and more.

**Servomotors, micro (2)**  
Servos don’t spin, they turn to precise positions. These are rated 4.2–6V, operating speed 0.10sec/60° (at 4.8V), stall torque 1.8kg/cm.

**Motor, mini DC (1)**  
Rated at 1.3V, 35mA, it spins at 16,000rpm. Housing measures just 16mm×6mm diameter.

**Motor, vibration (1)**  
The kind found in cell-phones. It buzzes about 50 decibels (dB) loud at 3V, 90mA, and will kick in at just 2V.

**Force-sensitive resistors (pressure sensors) (2)**  
Variable resistors that decrease in resistance when pressed with as little as 2 grams of force.

**Tilt sensors (2)**  
Tiny switches with a metal ball inside that, when tilted 30°, connects the contact points, closing the circuit. Rated at max 6mA/24V DC.

**Photoresistors (light sensors) (2)**  
Variable resistors that decrease in resistance as light intensity increases. Rated 150V, 100mW, 16kΩ–2MΩ.

**Thermistors (temperature sensors) (2)**  
Also variable resistors, NTC-type thermistors decrease in resistance as temperature rises. Rated at 50mW, 20kΩ–1MΩ.

**Speaker, 8Ω, with leads (1)**  
This tiny loudspeaker measures just 13mm in diameter, so it’ll fit into almost any project or prototype.

**Buzzer, piezoelectric, 12mm (1)**  
Rated at 5V, 28mA, it puts out 85dB at 2.3kHz. Piezos vibrate when current is applied. In reverse, they generate a voltage when vibrated!

**LCD alphanumeric display screen, 16×2 (1)**  
Has 2 lines of 16 characters, in blue pixels over a yellow-green LED backlight, and measures 80mm×36mm×15.8mm.

Datasheets available at [makeprojects.com/v/msump](http://makeprojects.com/v/msump)
LEDs, 3mm: green (5) and red (5)
Light-emitting diodes are polarized, with a longer positive lead (anode) and shorter negative lead (cathode).

LEDs, 5mm, tricolor RGB (3)
Combines red, green, and blue LEDs to reproduce a spectrum of colors. These have 4 leads, sharing a positive (+) lead (anode).

Resistors: 330Ω (10), 10kΩ (10), and 1kΩ (10)
Resistors limit current and divide voltage. Their leads aren’t polarized (no + and –). Colored bands indicate resistance value in ohms (Ω) and power rating in watts (W). These are all 1/4W. See page 7 for the color codes.

Capacitors, ceramic: 10nF (10) and 100nF (10)
Like a temporary battery, capacitors store electrical charge. They have a max voltage rating and a capacitance value that’s rated in farads (F) and typically printed on the capacitor itself. See page 7 for the number codes.

Capacitors, electrolytic, 100µF (5)
Electrolytic capacitors are polarized, with one positive (+) and one negative (–) lead. They resemble little barrels.

Potentiometer, rotary (1)
Pots are variable resistors with a preset range of resistance that can be adjusted. They’re also rated by power (W) and voltage (V).

Transistor, NPN (1)
This semiconductor allows or restricts current, like a normally open switch activated by electricity. Has 3 leads: emitter, base, collector. 20V, 500mA.

Diode, 1N4004 (1)
Semiconductor that allows current to flow only in one direction, so it protects against voltage spikes. Polarized, with (+) and (–) leads, rated 1 amp.

Switches, mini SPST, momentary push-button, normally open, 12V, 15mA (5)
Closes (connects) a circuit temporarily when pushed. Otherwise it’s open.

Switches, mini DPDT (3)
It’s double-throw (has 2 closed positions, with 1 open position between) and double-pole (can open/close 2 different circuits).

Datasheets available at makeprojects.com/v/msump
Bill of Materials, cont.

Datasheets available at makeprojects.com/v/msump

Solderless breadboard, clear, 1/2 size (1)  
Transparent plastic, adhesive-backed. 2.2” x 3.4” (5.5 cm x 8.5 cm), 400 tie points: a terminal strip (300) and 2 distribution strips (100 each).

Protoboards, 7cm×9cm (2)  
These blank circuit boards have 30×24 holes indexed with letters and numbers, copper-backed for soldering, plus soldering tabs on 2 edges.

9V battery case with DC plug (1)  
Includes a sliding cover, switch, 6” 26AWG lead wires, and a 2.1mm×5.5mm×9.5mm DC plug that fits Arduino (easy assembly required).

Headers, female, 8-pin (5)  
Headers, female, 6-pin stackable (1)

Headers, male, 40-pin breakaway (2)  
Headers, male, dual 40-pin breakaway (1)

Deluxe Jumper Wire Pack (1)  
65 multi-color, flexible, stranded jumper wires that can be used over and over, with molded barrels and ¾” (1cm) stripped ends.

Header, female, 6-pin stackable (1)  
Headers, female, 8-pin stackable (3)

Protoboards, 7cm×9cm (2)  
Solderless breadboard, mini (1)  
Has 170 tie points, measures just 1.4”×1.6” (3.5cm×4.5cm), and fits perfectly on our MakerShield.

Heat-shrink tubing, ¼” dia., 30”  
Insulates and protects wire connections from abrasion and the elements. Slip it on, heat with a hair dryer or heat gun to shrink in place.

Component storage box (1)  
Double-sided, 6-compartment case that contains most of the smaller components on this list.

Pin headers allow you to plug and unplug components. We chose this assortment to fit the Arduino/Netduino perfectly.