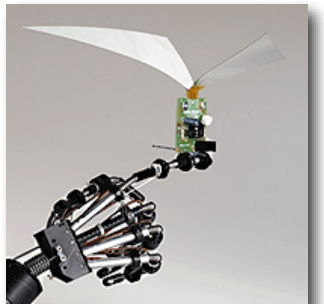
Space Wings™

Muscle Wires® Moving Electronics Kit



This Space Wings™ kit demonstrates the amazing capabilities of Muscle Wires® that actually shorten in length when powered!

- *Silent, graceful motion.*
- *Stands 15 cm (6 in.) tall.*
- *Adjustable: 6 - 36 cycles per minute.*
- *Includes circuit board, all parts, Flexinol®, history and information on Shape Memory Alloys, and complete instructions. (Requires soldering).*
- *Uses two AA batteries (not included).*
- *An excellent introduction to electronics.*

Easily assembles in under an hour. You will need: a soldering iron for electronics, solder, needle nose pliers, side cutter, small screw driver, hobby knife, straight edge ruler, transparent tape, two AA batteries (or 3 Volt DC Adapter). Electronics experience helpful but not required.

Where to put your Space Wings? On a desk lamp. In a potted plant. On a computer monitor. Where the sun shines.

DYNALLOY INC
14762 Bentley Circle
Tustin, CA 92780
USA

Phone 714-436-1206
Fax 714-436-0511
Email flexinol@dynalloy.com

I. Introduction

This Space Wings™ Kit demonstrates the amazing capabilities of Muscle Wires® that actually SHORTEN IN LENGTH when electrically activated. Review these instructions to become familiar with the parts in the kit. If you have not assembled electronics before, read Section V to learn about soldering.

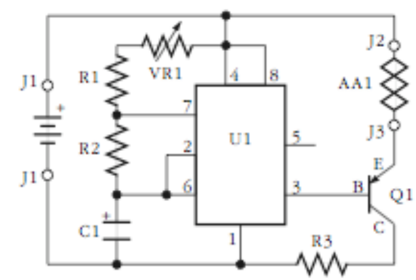
Bill of Materials - As you assemble the parts, refer to the list below and the instructions. Each item is indicated by its part number and location code.

Loc.	Qty	Unit	Description
1) -	1	ea	PC Board, Space Wings, Rev C
2) R1, R2	2	ea	Resistor, 75KΩ, 1/4W, 5% (Violet, Green,Orange, Gold)
3) R3	1	ea	Resistor, 1.6Ω, 1/4W, 5% (Brown, Blue, Gold, Gold)
4) U1	1	ea	Socket 8 pin, DIP
5) VR1	1	ea	Variable Resistor, 1MΩ, 1/4W, 5%
6) C1	1	ea	Capacitor, 10μf, electrolytic, radical
7) J1	1	ea	Jack Mini 2.5 mm
8) Q1	1	ea	Transistor, PN2907, PNP
9) J2, J3	2	ea	Screws, 4/40, 1/4", pan head, phillips, zinc
10) J2, J3	2	ea	Nut, Hex, 4-40
11) Stand	1	ea	Stand Wire (a paper clip)
12) U1	1	ea	Integrated Circuit, TLC555CP, 8 pin, DIP
13) J2, J3	6	cm	Flexinol®, 100 HT (90ºC)
14) -	1	ea	Plug, Mini, 2.5 mm
15) -	1	ea	Battery Holder, 3V, 2 x AA, with leads
16) AA1	1	ea	Wing Base Strip
17) -	1	ea	Polyester Sheet, Aluminized, 5 mil, 3" x 41/2"
18) -	1	ea	Instructions (these)

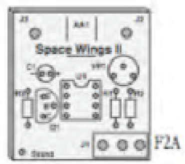
For continuous operation use 3 Volt, 200 mA adapter in place of the battery pack. with other adapters, if the output exceeds 200mA, using a limiting resistor. Levels over 200mA can overheat the Muscle Wire® and reduce its operating lifetime.

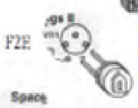
Schematic

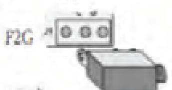
This schematic shows the connections of the Space Wings™ components. For a complete description of their functions and of the overall operation see Section IV.



II. Assemble the Circuit Board







2.1 Bend the leads on the 75KΩ (75,000 ohm) resistor color coded Violet, Green, Orange, Gold and insert into locations R1 and R2 on the Printed Circuit Board (PCB). Bend the leads slightly outwards (F2B) to hold the part flush against the board and solder in place.

2.2 Bend the 1.6Ω (1.6 ohm) resistor (colored Brown, Blue, Gold, Gold), insert at R3 and solder (F2C). Trim away excess leads.

2.3 Insert IC socket into location U1 (F2D), with the notched end toward the top, as printed on the board. Solder all pins, using care to not bridge any of them with excess solder.

2.4 Insert the 1MΩ (1,000,000 ohm) variable resistor (also called a potentiometer) into location VR1 (F2E). Bend the leads slightly and solder into place.

2.5 Insert the capacitor into location C1 (F2F) with the "-" and "+" on the part matching the holes as printed on the board. Solder and trim.

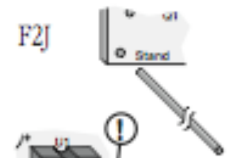
2.6 Insert the 2.5 mm mini jack at J1 (F2G) and solder.

2.7 Insert the transistor into location Q1 (F2H), with the curved side as indicated on the circuit board. Push in until it stands about one centimeter above the board (F2.9). Solder and trim.

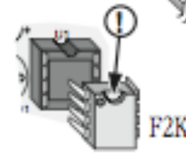
2.8 Insert a screw into J2 from the FRONT of the circuit board, and into J3 from the BACK (F21). Secure in place with nuts, but do not tighten until later.

2.9 Inspect the board. All parts should be correctly positioned (especially C1, U1 and Q1). All solder joints should look clean, bright, smooth, and have no holes. There should be no excess solder joining or bridging separate solder points. Heat and remove excess solder and re-solder cold joints.

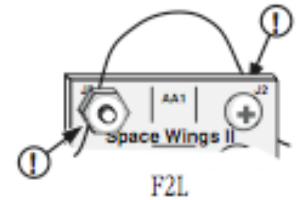
2.10 Straighten the stand wire, insert it at the hole marked "stand" and solder it in place with an equal amount extending from both sides of the PCB (F2J). Bend the wire slightly so it supports the PC board



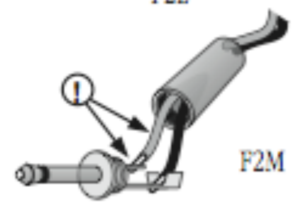
2.11 Insert the Integrated Circuit, the TLC555 Timer in the socket at U1, with pin 1 at the top left (F2K). Be sure that all legs sit properly and do not bend underneath or extend outside the socket.



2.12 Position one end of the Muscle Wire® under the screw head at J2, and the other under the screw head at J2. Note how it arches over the top of the board at AA1. Temporarily secure both the screws, leaving as much slack in the Muscle Wire® as possible (F2L).

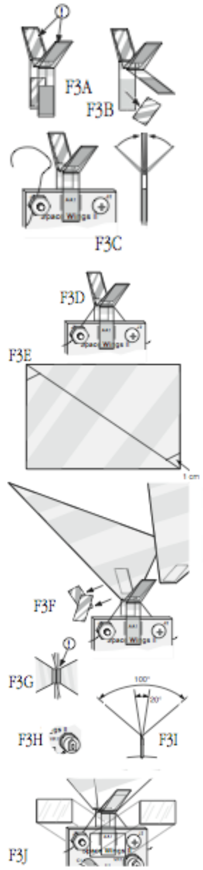


2.13 Remove the mini-plug's cap and tread the Battery Holder wires through the small end first (F2M). Solder the RED wire (+) to tip and BLACK (-) to body. Crimp the strain relief, and replace the cap.



2.14 Install two AA batteries in the battery holder and test the output with a volt meter to be sure the TIP is POSITIVE. Test the circuit by plugging the battery pack (or an 3 Volt, 200 milliamps AC adapter) into J1. After a few moments the Muscle Wire® should move slightly. If it does not move, remove power. Check the batteries or outlet. Review all steps. Look for misplaced parts, bad joints, solder bridges, etc.

If it still does not function, refer to the schematic and use a voltmeter to check for proper input voltage, circuit continuity, and output signal at pin 3 on U1 (Pin 1 is the leg of the IC closest to C!). When everything works correctly, go on to Section III.



III. Assemble the Wings

After verifying that the circuit built in Section 2 functions, remove power.

3.1 Loosen one end of the Muscle Wire® and move it out of the way. Fold the wing base strip into "Y" with the CENTER adhesive strips facing UPWARDS (as shown in figure 3A).

3.2 Remove the backing from one of the END adhesive strips (F3B). Press the adhesive tab to the board at location AA1, with the strip extending straight away from the edge. Repeat on the other end, positioning the strip so that when closed, the wing base points straight away from the board (F3C).

3.3 Pass the Muscle Wire® through the "y" of the wing base and position the wire so it just begins to pull the wing base closed (F3D). Tighten the screw to hold the wire in place.

3.4 With a hobby knife and straight edge ruler, cut the polyester sheet from corner to corner, and trim the lower corners to make a small flat edge 1 cm (1/2 inch) long (F3E).

3.5 Remove one backing strip from the center of the wing base. Position a wing with the small flat edge in the wing base's "V" and the longest edge positioned above the stand wire(F3F). Leaving a small gap between the bottom of the wing and the Muscle Wire® (F3G), press the wing onto the adhesive.

3.6 Attach the second wing, aligning it with the first. Press both wings securely to the adhesive.

3.7 With a small screwdriver or your fingers, adjust variable resistor VR1 to a middle position (F3H).

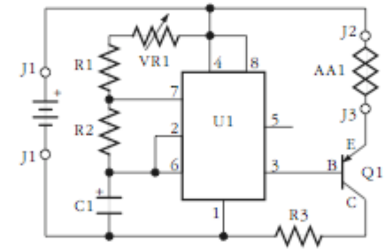
3.8 Plug the battery pack or adapter into the circuit board. Turn VR1 to change the rate of motion.

3.9 The weight of the wings will extend the Muscle Wire®. Let the circuit run for a few cycles, then adjust the Muscle Wire® so the wings nearly close when up, and relax to about 100° (F3I). There is a point where it works perfectly - keep trying until you find it. If the wings lean to one side or the other when up, lift one end of the wing base from the board, and raise or lower it until the wings close directly over the board.

3.10 After operating for a few hours, the wing base mechanism may settle and require slight adjustment.

3.11 When adjusted, secure the wing base with a piece of transparent tape on each side of the board. Depending on the flapping rate set by VR1, the batteries should last from 5 to 10 hours of continuous operation. Place the Space Wings™ in a safe place away from curious cats and hungry vacuum cleaners. Plug it in and watch it go.

IV. How it Works



The 555 Timer Integrated Circuit, U1, contains over forty transistors, resistors, and diodes. The timer acts as an oscillator, turning on and off to control the speed of the wings raising and lowering.

The resistors R1, R2 and VR1, and capacitor C1 set the rate and duty cycle of the 555's output signal at pin 3. A smaller capacitor would run the wings at a faster rate, and different resistors would change the ratio of the duty cycle's "on" and "off" times.

The transistor Q1 acts like a switch that controls power to the Muscle Wire®. It has three legs called emitter (E), base (B), and collector (C). When the voltage at the base is high (when U1 pin 3 is "on") power flows between the emitter and collector.

The batteries provide 3 Volts to the timer U1 and Muscle Wire®, and 1.6Ω resistor R3, help limit the current flow and protect the Muscle Wire® from overheating.

When the transistor permits power to pass through the Muscle Wire®, the wires resistance (about 2 ohms) causes it to hear to over 100° (212°F). Due to the wire's small mass, it never feels hot to touch. Heating the wire activates the crystal structure's phase change (see Section 5), and the wire shortens by 3 to 5 percent.

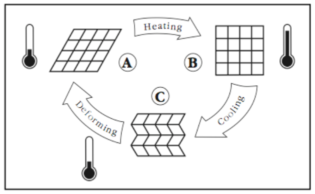
The contracting Muscle Wire® exerts up to 1.5 Newtons (150 grams) of force on the wing base. The structure of the wing base acts as a mechanical lever that trades the Muscle Wire®'s small motion and relatively large force for a larger motion and a smaller force at the wing tips.

As the wings reach the top of their stroke, their center of gravity moves inward, and they oppose the Muscle Wire® with less force. Also, the wing base can bow outward to absorb any extra contraction on the wire. These "reverse bias" features protect the Muscle Wire® from excess strain as it contracts.

The orange polyamide tape on the wing base can take repeated heat and flexing without damage. NASA's Space Shuttle and many satellites use polyamide films in protective blankets that must be lightweight, strong and tolerate extreme temperatures. The rigid polyester wings, have a layer f vaporized aluminum metal that makes the shine and reflect like a mirror.

When the 555 time turns the transistor "off", power stops flowing through the Muscle Wire®. Surrounding air carries the heat away from the wire, and it relaxes, returning to its starting length. Gravity pulls the wings back down, and

V. About Muscle Wires®



Muscle Wires® belong to the class of metals known as Shape Memory Alloys (SMA's) having crystal structures that can assume different shapes at distinct temperatures. At low temperatures (F5c), Muscle Wires® can be easily stretched (F5a), then when reheated they return to their original shape with a usable force and speed (F5b). In 1932 Swedish researcher Arne Olander observed the shape recovery abilities of a gold-cadmium alloy, and noted its potential for creating motion. In 1950, L.C. Chang and T.A. Read, at Columbia University in New York, used X rays to study the alloy and to understand the phase change of its crystals.
In 1961, while researching for non-corrosive marine alloys, a team led by William Beuhler at the U.S. Naval Ordnance Laboratory (NOL) found the shape memory effect in an alloy of nickel and titanium. They named the alloy Nitinol (pronounced "night in all"), an acronym of Nickel, Titanium and NOL. On disclosure, their discovery generated much interest. During the 1960's and 70's researchers worldwide observed the shape memory effect in various titanium, copper, iron and gold alloys. NASA studied SMA's for applications such as satellite antennas that would expand from the heat of the sun, and others developed engines that operated in hot and cold water.

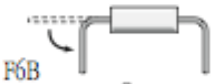
Universities and companies researched commercial applications of SMA's. Among the most successful applications, Raychem Corporation introduced a line of SMA pipe connectors that would shrink to fit and provide highly reliable seals for jet engines and hydraulic systems.

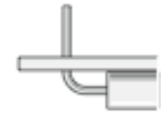
When drawn into wires, Nitinol can be easily heated by an electric current, and with additional processing, as with Muscle Wire®, the wires can contract and relax for millions of cycles. SMA wires function like electric muscles, and could contribute to robotic and prosthetic devices that would be difficult to make using other methods.

See our "Muscle Wires® Project Book" with fascinating hand-on projects, circuits, devices, history, references, software listings and essential secrets for maximum performance. Exploring amazing new devices from simple levers to complete motor less miniature walking robots. Visit Musclewires.com for more!

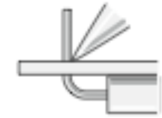
VI. Assembling Electronics


F6A


F6B


F6C


F6D


F6E


F6F


F6G

If you have never assembled electronics you should read about the basics before you begin. The steps below outline the basic procedures for preparing, soldering and inspecting many kinds of electronic components. With a few tools and a little patience's you will have no trouble assembling, testing and displaying you Space Wings™.

F6A - Basic tools needed: Soldering iron, small sponge, electric solder, needle nose pilers, side cutters. Optional: spare soldering iron tip, flux remover.

Plug in the iron, and moisten the sponge with water. When hot, "tin" the soldering iron's tip with a small amount of solder (replace the tip if old or corroded). Wipe the tip across the wet sponge from time to time to keep it clean. A clean, well-tinned tip does best.

F6B - Bend the component leads to fit the holes on the board.

F6C - Insert the component, observing any special orientation it may require. Bend the leads enough to hold the part against the board, but do not over bend.

F6D - Wipe the tip clean and tin with a small amount of solder

F6E - Heat the joint by placing the soldering iron's tip against both the component lead and the circuit board pad.

F6F - After a moment of heating, touch the solder to the lead, pad and iron. When the solder flows, remove it, and hold the tip in place for one second. Remove the iron and, without moving the part of board, wait for the joint to cool.

F6G - Trim excess component lead with the side cutter. Parts with short leads do not need to be trimmed.

Inspect the joint, a good solder joint blends the lead and pad smoothly together, and has a smooth, bright finish. If the joint or bridges to other pads re-melt it, and remove the excess solder with the solder iron. if the joint looks fuzzy or dull it is a "cold" solder joint. Re-melt it, and let it cool (without moving) to a smooth bright finish.

Optional: After finishing all soldering, you may with the clean the board to remove any flux residue. Use a commercial flux remover, and follow its instructions.