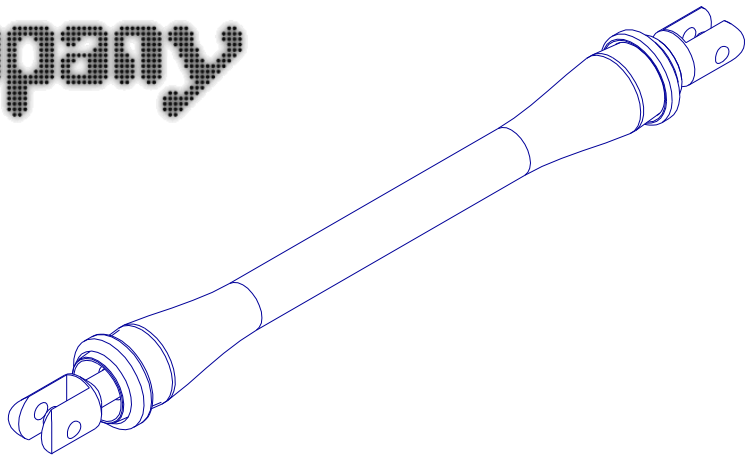
The Shadow Robot Company

Shadow Air Muscle

30mm



General Overview

The Shadow Air Muscle is a simple yet powerful device for providing a pulling force. It behaves in a very similar way to a biological muscle. When actuated with a supply of compressed air, it contracts by up to 37% of its original length. The force it provides decreases as it contracts, and the first few percent of the contraction is very powerful indeed.

The simplest use of a muscle is to move a lever. One muscle will pull the lever in one direction, and a spring can return it. Two muscles will allow the lever to be pulled in either direction, with considerable force. Because the muscle contracts over a known distance, it can be used to provide a safe movement. there is no need to ensure that the lever is not going to be rotated beyond its end-stop, since the muscle will only move the lever to its set up angle.

Features

- **Lightweight:** Air Muscles weigh between 10g and 150g, depending on size – particularly useful for weight critical applications. The 30mm Air muscle weighs 80g.
- **Smooth:** Unlike pneumatic cylinders, Air Muscles have no 'stiction', and an immediate response. This results in a smooth natural movement.
- **Flexible:** Air Muscles need no precise aligning.
- **Powerful:** Air muscles produce forces up to 700 N at pressures of only a few bar.

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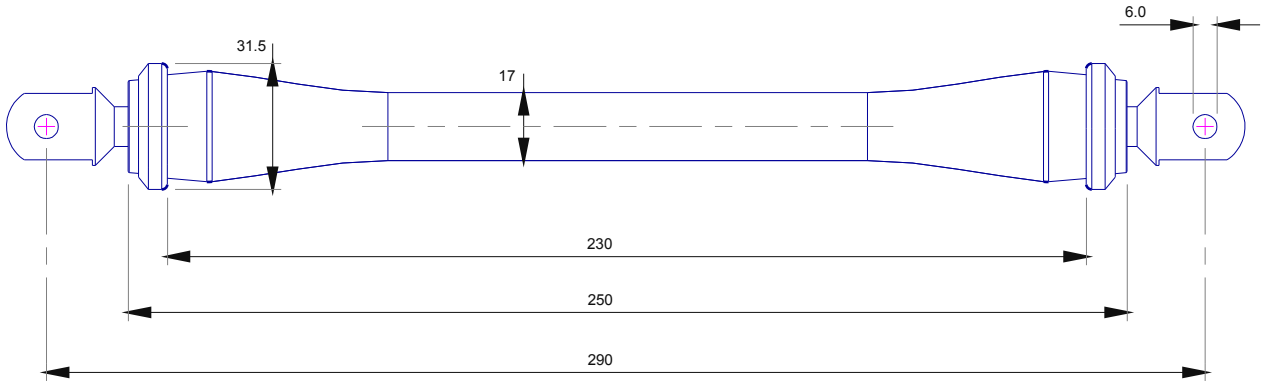
Dimensions

Extended:

These measurements are taken when the muscle is fully stretched out, under a load of at least 50N, and a pressure of 0 bar.

Hole – Hole Spacing [1]	290mm
Total Muscle Length [2]	250mm
Active Length [3]	230mm



1: The Hole-Hole spacing is the distance between the holes in the fittings at either end of the muscle. This is adjustable, as the fittings can be screwed in or out. They can also be removed entirely, creating a more compact muscle. Use an M10 screw instead, and remember to use PTFE tape to ensure a good seal.

2: The Total Muscle Length is the length of the whole muscle, excluding the fittings.

3: The Active Length is the length of the part of the muscle which contracts under pressure, and does not include the headers.

Because the muscle is a flexible actuator, these measurements are approximate, except where given to one decimal place. Actual distances measured are a function of the pressure, and load of the muscle.

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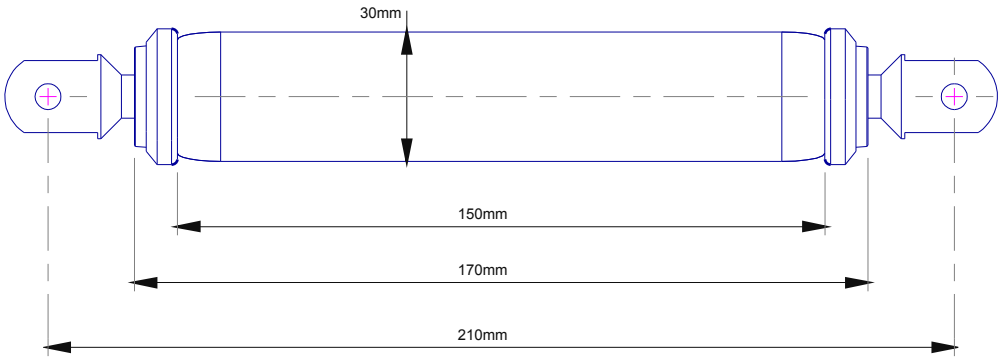
Contracted:

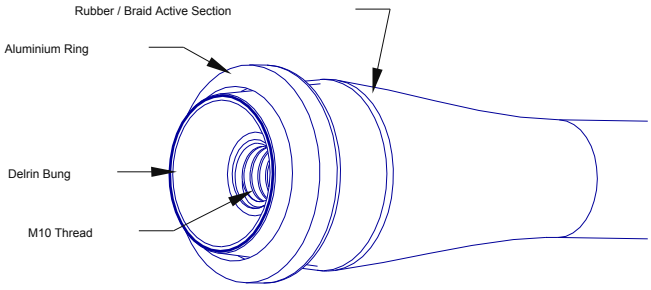
These measurements are taken when the muscle is pressurised to 3bar, with a load of 50N.

Hole – Hole Spacing	220mm
Total Muscle Length [2]	180mm
Active Length [3]	160mm

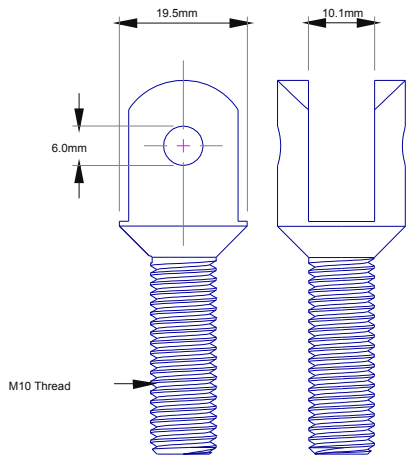


Headers and Fittings:

The header at each end of the muscle consists of an Aluminium ring, and a Delrin plastic bung, with an M10 female thread. This thread can be used as a means of attachment, and to allow air into or out of the muscle.



The muscle is supplied with two Delrin fittings, one of which comes with a 6mm push-fit connector.



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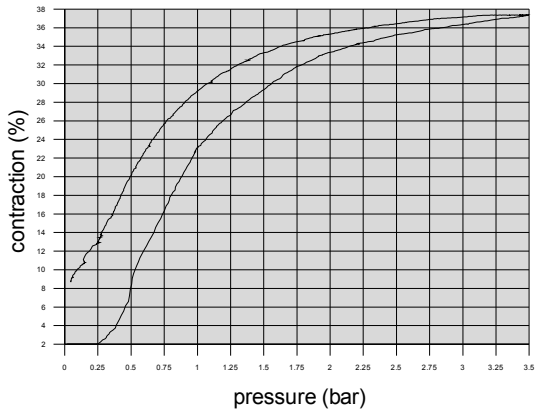
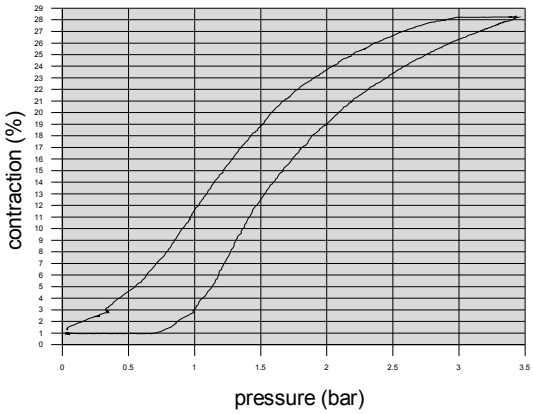
Dynamic Characteristics

The following graphs show the contraction of the muscle as the pressure is increased to 3.5 bar (lower line), then decreased back to 0 bar (upper line), under several static loads.

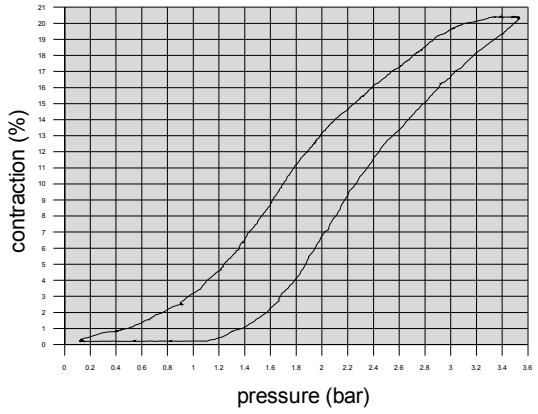
45 N load



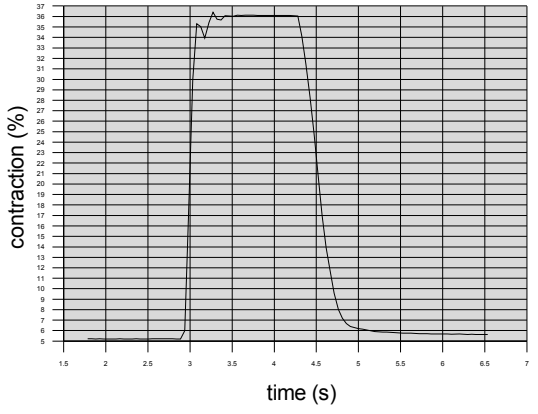
130 N load



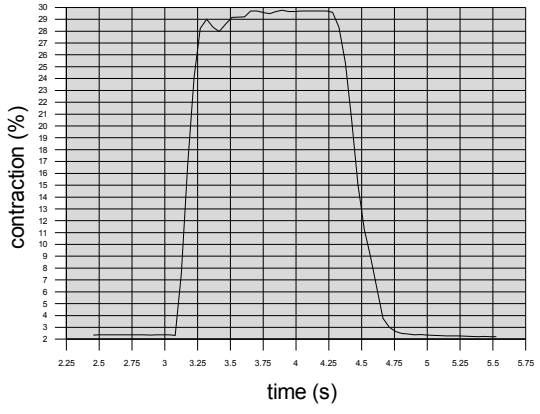
260 N load



Fill Speed 45N, 3.5bar



Fill Speed 130N 3.5bar



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Usage

If you have some experience with pneumatics, then you will probably have used cylinders in the past to produce movements. If you are now trying air muscles, there are some important differences that you should be aware of.

Pneumatic cylinders produce a small force over a long movement. Air muscles, on the other hand produce very high forces, but pull relatively short distances. Therefore cylinders and air muscles are used in different ways, and are generally for slightly different applications.

The Shadow Air Muscle is a powerful actuator, which can exert large forces, over a short distance at low air pressures.

Air muscles are most effective at the beginning of their stroke (fully extended), giving a high force and good responsive movements. When a muscle is contracted, increasing the pressure will only stress it, and produce almost no more movement (and may push the rings off)

<u>If you find that your muscle is not producing enough movement:</u>

DO NOT: Increase the pressure. This will only serve to reduce the life of the rubber.

DO: Tighten any tendons, ropes, or means which attach the muscle to the mechanism. Make sure that, at the beginning of the mechanism's movement, the muscle is pulled out as tight as possible, like a guitar string.

DO: Adjust your mechanism, so that less movement is required from the muscle. For levers etc, this generally means attaching the muscle closer to the pivot point. For pulleys, this means using a smaller pulley. Of course, this in turn means that the muscle will have to pull harder, but this is exactly what muscles are good for; high forces over short distances.

DO: Try a longer muscle, if space allows.

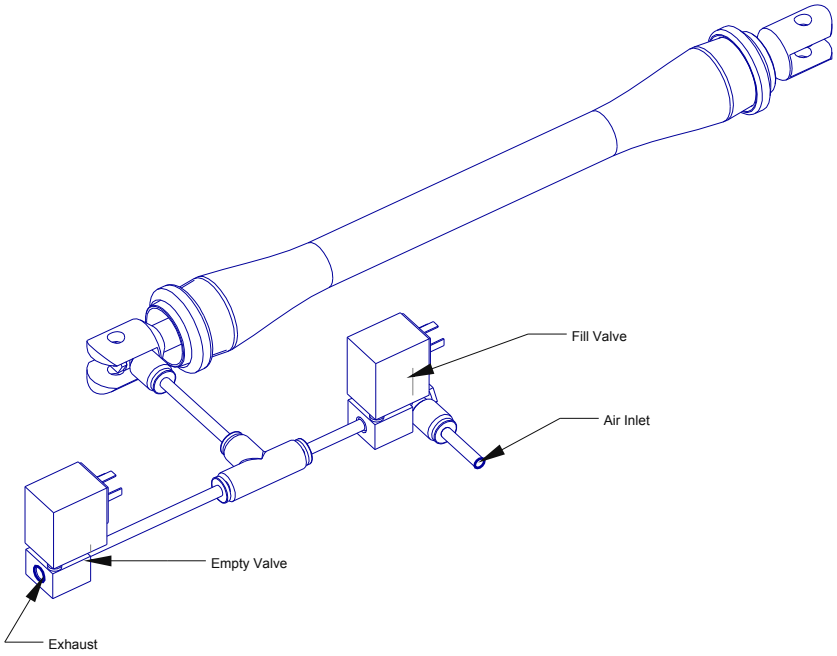
If, having tried all of the above, you still feel that an increase in pressure is needed, then slightly increase the pressure. If this slight increase gives a noticeable improvement, then good, otherwise, turn the pressure back down.

Adjustment:

When designing mechanisms to be actuated by air muscles, it is always a good idea to provide some adjustment means to tighten or loosen the muscle as needed. You might design in a movable attachment point, or some way to tighten the tendons. Before you use the mechanism, move it to one extreme, so that the muscle is pulled out, and while holding it in that position, use your adjustment means to make sure the muscle is nice and tight at this point. Now, move the mechanism to the other extreme. The muscle should have contracted about 20% - 30% of its active length.

Pneumatic Setup

In a typical situation, a muscle requires two pneumatic valves to operate. One valve lets air into the muscle, the other lets air out. By controlling the opening of each valve, it is possible to set the desired contraction of the muscle.



The throughput of the valves, the pressure of the air supply, the bore and length of tube used, will all affect the speed of the Air Muscle.

If you require the maximum speed of contraction/extension, you should select high throughput valves, and attach them as close as possible to the muscle, using the largest bore tube possible. Typically, you can expect the muscle to contract within about 0.5s, depending on conditions. If conditions are optimal, it is possible to achieve contraction times as low as 0.1s.

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If you require a slower, or more controlled movement, you should consider adding air restrictors into the tubes. This way, it is possible to slow the movement to anything, down to a standstill. One great advantage of Air Muscles is their ability to move extremely smoothly, even at very slow speeds.

Care

Shadow Air Muscles last longest when they are being used with high loads, at low pressures. The less they bulge, the longer they last. In general, the muscle the should be kept in the 0% - 20% contraction range.

Make sure that, as the muscle contracts, the soft rubber / braiding part is not touching or rubbing on anything, as abrasion or piercing can cause premature failure.

Warnings:

Never, under any circumstances, inflate the muscle with no load. Doing so can push the rings off.

Never pressurise the muscle to more than 3.5 bar pressure.

Shadow Air Muscles can produce very large forces, especially when fully extended.

Always take care when using muscles, and make sure they are never used in a situation where their movement could cause injury.

Shadow Air Muscles are not rated or warranted for use in safety critical applications without explicit written authorisation from the Shadow Robot Company.

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