

## Fluidic Muscle DMSP/MAS

**FESTO**



# Fluidic Muscle DMSP/MAS

Key features

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## At a glance

### High initial force and acceleration

- Initial force up to 10 times higher than a conventional cylinder of the same diameter
- Highly dynamic response, even at high loads

### Judder-free operation

- No mechanical parts moving against one another
- Completely jolt-free with extremely slow movements

### Simple positioning

- Controlled by means of pressure using the simplest technology without displacement encoders

### Hermetically sealed design

- Separation between operating medium and atmosphere
- Ideal for dusty and dirty environments
- Robust design
- Zero leakage

## Mode of operation

Fluidic Muscle is a tensile actuator which mimics natural muscular movement. It consists of a contraction system and appropriate connectors. The contraction system is formed by a pressure-tight length of rubber hose, sheathed in high-strength fibres. The fibres create a rhomboidal pattern with a three-dimensional grid

structure. When internal pressure is applied, the hose expands in its peripheral direction, thus creating a tensile force and a contraction motion in the muscle's longitudinal direction. The usable tensile force is at its maximum at the start of the contraction and then decreases in a virtually linear manner as a function of stroke.

An efficient operating range is provided with contractions of up to 15% of the nominal length.

The applications of Fluidic Muscle are as follows:

- Single-acting actuator
- Pneumatic spring



### Note

Fluidic Muscle is intended for use as a tensile actuator only. The expansion in the peripheral direction cannot be used for clamping purposes, since external friction could cause damage to the muscle.

## Fluidic Muscle DMSP, with press-fitted connections

→ 8



The Fluidic Muscle DMSP with press-fitted connections is the result of a thorough analysis of the requirements specification that already existed for the Fluidic Muscle MAS. The resulting new development is therefore considerably lighter, more compact and durable.

- More compact design with more muscle, achieved thanks to a 25% more compact cross section.
- Up to 30% less weight, which translates into a superb force/weight ratio.
- Choice of three integrated adapter variants.

## Fluidic Muscle MAS, with screwed connections

→ 18



The Fluidic Muscle MAS is characterised by a long service life that is made possible through the use of optimised materials. The Fluidic Muscle MAS is also available with an adapter and force-safety device.

- The force-safety device makes it possible to limit the lifting force, which can for instance protect against trapping objects.
- Use of customer-specific adaptation options.

# Fluidic Muscle DMSP/MAS

Key features

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## Sizing the muscle

### Sizing software

Sizing should be carried out using the MuscleSIM software.

This software can be downloaded from  
→ [www.festo.com](http://www.festo.com).

### Graphical sizing

Apart from sizing the muscle using the software, it is also possible to define the length of the muscle with the aid of force/displacement diagrams.

Graphical sizing of the muscle is explained with the aid of two examples  
→ 32.

## Force curve and load cases

The nominal length of the pneumatic muscle is defined in the non-pressurised, load-free state. It corresponds to

the visible muscle length between the connections. The muscle extends

when it is pretensioned by an external force. When pressurised, on the other

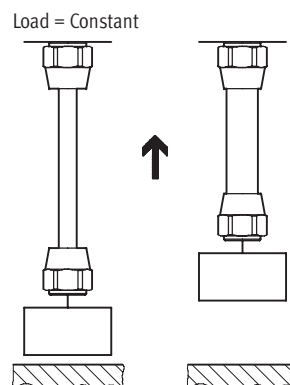
hand, the muscle contracts, i.e. its length decreases.

## Single-acting actuator

Sizing examples → 32

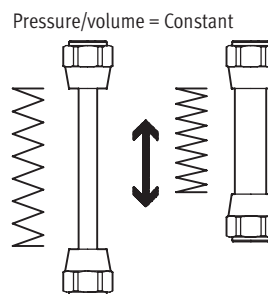
In the simplest case, Fluidic Muscle operates as a single-acting actuator against a constant load. Assuming that this load is permanently attached to the muscle, it will project from its initial position when in the extended non-pressurised state. This operating status is ideal with regard to the technical properties of Fluidic Muscle: when pressurised, a Fluidic Muscle pretensioned in this way develops

maximum force with optimum dynamic characteristics and minimum air consumption. The usable force is also at a maximum in this case. If a Fluidic Muscle is required to be free of forces in the extended state, for example to allow a load to be attached, a holding force must first be developed for lifting purposes, leaving a small force component for the motion itself.



Fluidic Muscle behaves like a spring with a changing external force: it follows the direction of action of the force. With Fluidic Muscle, both the pretensioning force of this “pneumatic spring” and its spring stiffness can be varied. Fluidic Muscle can be

operated as a spring with constant pressure or constant volume. These produce different spring characteristics that enable the spring effect to be matched perfectly to a given application.



## Note

If the muscle is fed with compressed air and the volume blocked, the pressure in the muscle can increase significantly when the external force

is varied. The service life of the Fluidic Muscle depends on the contraction, the operating pressure and the temperature → 34.

High operating frequencies or high loads can lead to a temperature rise.

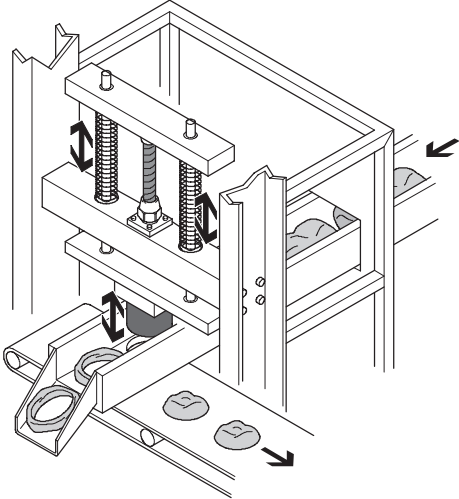
# Fluidic Muscle DMSP/MAS

Typical applications

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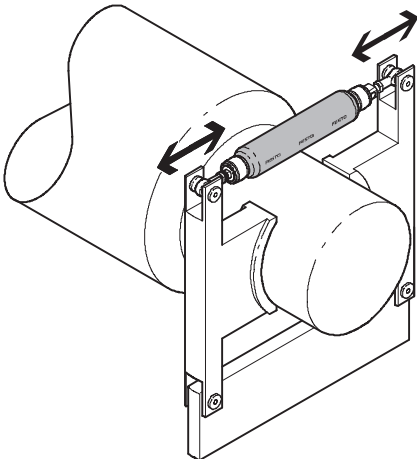
## Force and dynamism

Drive for tab punching



Very high cycle rates are possible with the muscle, on the one hand because of its low weight and on the other because it has no moving parts (e.g. piston). The simple construction – one muscle pretensioned using two springs – replaces a complicated toggle lever clamping system using cylinders. This makes a frequency increase of 3 to 5 Hz possible. Over 50 million load fluctuations can be achieved in this way.

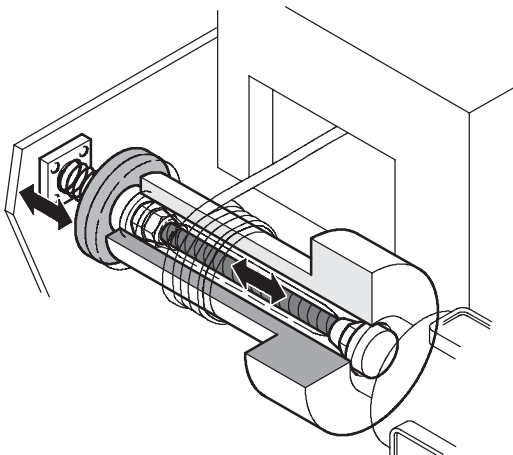
## Emergency stop for rollers



The fluidic muscle is setting new standards in applications that require fast response times. The emergency stop for rollers demands both speed and force. Long machine downtimes in the event of malfunctions can thus be prevented.

## Judder-free movements

Brake actuator for rewinding equipment



The friction-free muscle allows uniform and gentle braking of the pay-out reel, ensuring highly precise winding at constant speed. Control is provided by a proportional control valve whose signals are regulated via force sensors.

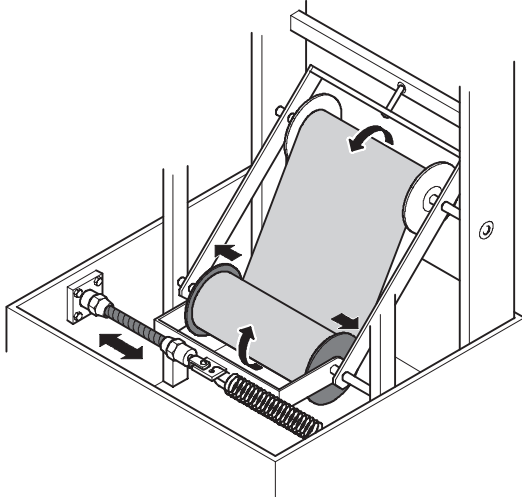
# Fluidic Muscle DMSP/MAS

Typical applications

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## Judder-free movements

Belt edge control for winding processes



The aim:

uniform winding of paper, foil or textiles.

The requirement:

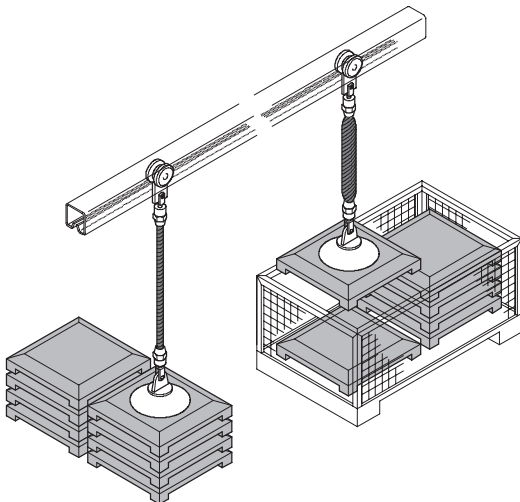
a friction-free drive with quick and immediate response characteristics.

The solution:

Fluidic Muscle. The drum attached to a moving frame is displaced by a pneumatic muscle as soon as the sensor detects misalignment. This means that the winding edge control is 100% efficient.

## Simple positioning systems

Simple lifting device for manipulating concrete slabs and car wheel rims

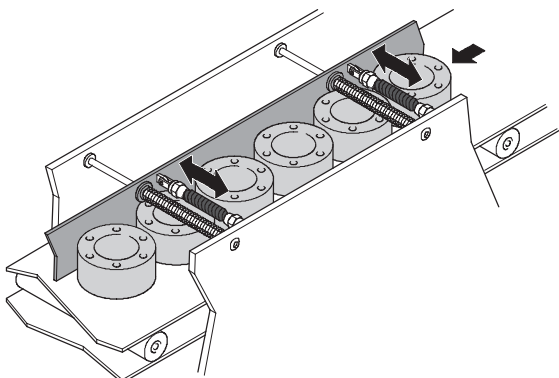


Approximate intermediate positions?

No problem with pressure regulation.

The workpieces can be raised or lowered as required by pressurising or exhausting the muscle via a hand lever valve. Muscle lengths up to 9 m facilitate various types of application.

## Adjusting the width of conveyor belts



With small batch sizes, it is often necessary to adapt entire system sections to different component dimensions after a short period of time. This task can be performed with the fluidic muscle in cases where an approximate adjustment is sufficient.

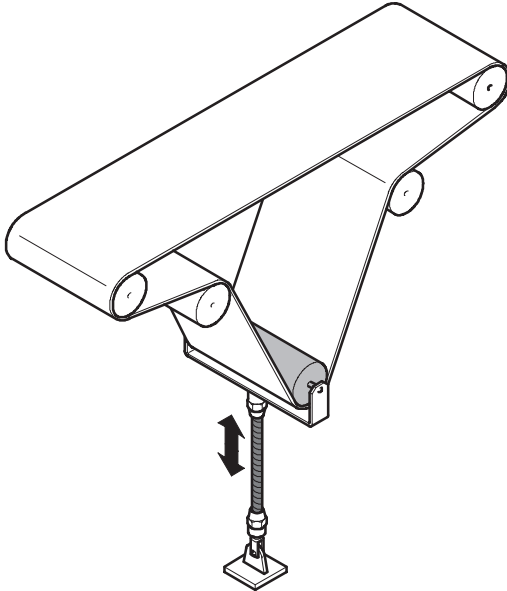
## Fluidic Muscle DMSP/MAS

Typical applications

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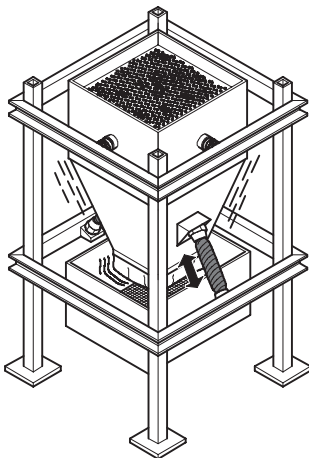
### Harsh environmental conditions

Belt tensioner for conveyed goods



In dusty or dirty environments, a hermetically sealed fluidic muscle has a major advantage over conventional drives. This seal cannot wear. It is a sturdy, contractible tube that copes with the tough demands of the cement industry with ease.

### Drive for a vibratory hopper

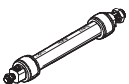
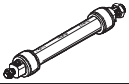
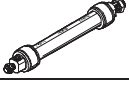
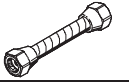
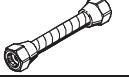


Hoppers and silos are susceptible to the problem of parts jamming during feeding. Fluidic Muscle facilitates stepless regulation of a pneumatic shaker between 10 and 90 Hz, thereby guaranteeing continuous delivery.

# Fluidic Muscle DMSP/MAS

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Product range overview

| Function                      | Version                                                                             | Type | Inside dia.<br>[mm] | Nominal<br>length<br>[mm] | Lifting<br>force<br>[N] | Max. permissible<br>pretensioning | Max. permissible<br>contraction | Operating<br>pressure<br>[bar] | → Page/Internet |
|-------------------------------|-------------------------------------------------------------------------------------|------|---------------------|---------------------------|-------------------------|-----------------------------------|---------------------------------|--------------------------------|-----------------|
| Single-<br>acting,<br>pulling | Fluidic Muscle with pressed connection                                              |      |                     |                           |                         |                                   |                                 |                                |                 |
|                               |    | DMSP | 10                  | 40 ... 9000               | 0 ... 630               | 3% of nominal length              | 25% of nominal length           | 0 ... 8                        | 8               |
|                               |    | DMSP | 20                  | 60 ... 9000               | 0 ... 1500              | 4% of nominal length              | 25% of nominal length           | 0 ... 6                        | 8               |
|                               |    | DMSP | 40                  | 120 ... 9000              | 0 ... 6000              | 5% of nominal length              | 25% of nominal length           | 0 ... 6                        | 8               |
|                               | Fluidic Muscle with screwed connections                                             |      |                     |                           |                         |                                   |                                 |                                |                 |
|                               |    | MAS  | 10                  | 40 ... 9000               | 0 ... 630               | 3% of nominal length              | 25% of nominal length           | 0 ... 8                        | 18              |
|                               |   | MAS  | 20                  | 60 ... 9000               | 0 ... 1500              | 4% of nominal length              | 25% of nominal length           | 0 ... 6                        | 18              |
|                               |  | MAS  | 40                  | 120 ... 9000              | 0 ... 6000              | 5% of nominal length              | 25% of nominal length           | 0 ... 6                        | 18              |

 Note

When replacing a Fluidic Muscle MAS and accessories MXAC (first-generation products available until 06/2005) as listed in the table opposite with a Fluidic Muscle MAS and mounting accessories MXAD as described in this document (part numbers → 1 / 5.6-28), please consult your contact person at Festo. Compatibility cannot be guaranteed in all cases due to changes in installation dimensions.

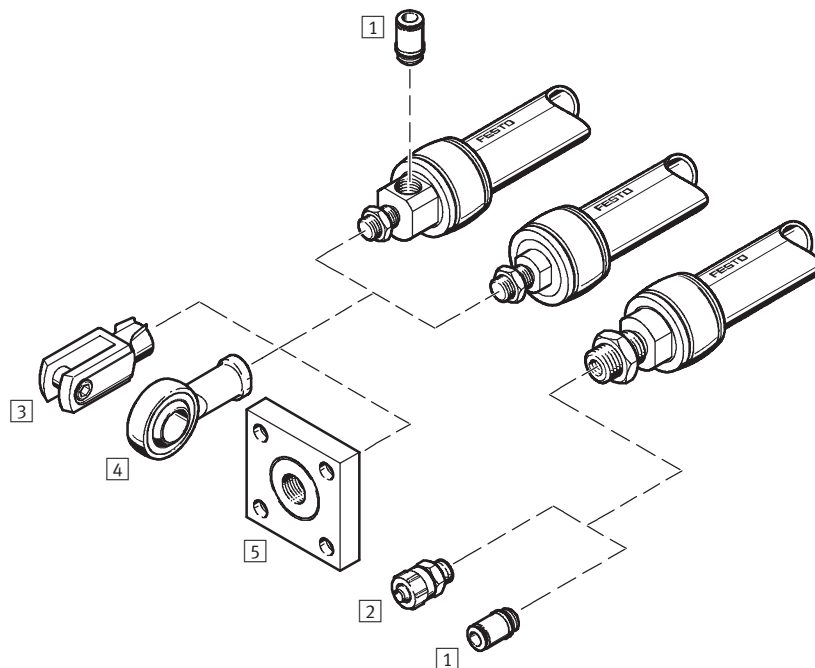
 To be discontinued

| Fluidic Muscle MAS |                      | Mounting accessories MXAC |          |
|--------------------|----------------------|---------------------------|----------|
| Part No.           | Type                 | Part No.                  | Type     |
| 187 594            | MAS-10-N-...-AA-MCFK | 187 591                   | MXAC-B10 |
| 187 595            | MAS-10-N-...-AA-MOFK | 187 592                   | MXAC-A10 |
| 187 617            | MAS-20-N-...-AA-MCHK | 187 593                   | MXAC-R10 |
| 187 618            | MAS-20-N-...-AA-MCGK | 187 614                   | MXAC-B16 |
| 187 619            | MAS-20-N-...-AA-MOHK | 187 615                   | MXAC-A16 |
| 187 605            | MAS-40-N-...-AA-MCKK | 187 616                   | MXAC-R16 |
| 187 606            | MAS-40-N-...-AA-MCIK | 187 602                   | MXAC-B20 |
| 187 607            | MAS-40-N-...-AA-MOKK | 187 603                   | MXAC-A20 |
|                    |                      | 187 604                   | MXAC-R20 |

# Fluidic Muscle DMSP, with press-fitted connections

Peripherals overview

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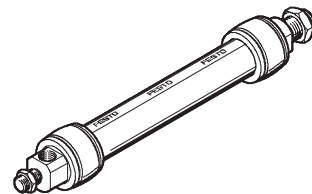
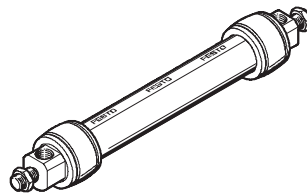
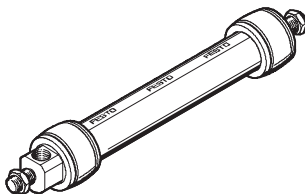


## Variants

Pneumatic connection, radial, at one end,  
RM-CM

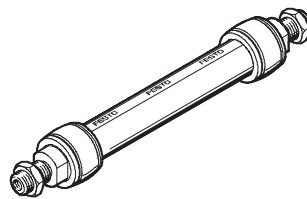
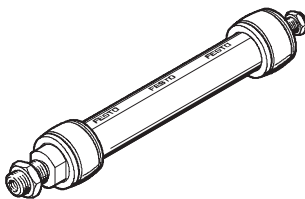
Pneumatic connection, radial, at both ends,  
RM-RM

Pneumatic connection, radial and axial,  
RM-AM



Pneumatic connection, axial, at one end,  
AM-CM

Pneumatic connection, axial, at both ends,  
AM-AM



## Mounting attachments and accessories

|                              | Brief description                                                     | → Page/Internet |
|------------------------------|-----------------------------------------------------------------------|-----------------|
| 1 Push-in fittings<br>QS     | For connecting compressed air tubing with standard external diameters | quick star      |
| 2 Quick connectors<br>CK     | For connecting compressed air tubing with standard internal diameters | ck              |
| 3 Rod clevis<br>SG           | Permits swivel motion of the Fluidic Muscle in one plane              | 17              |
| 4 Rod eye<br>SGS             | With spherical bearing                                                | 17              |
| 5 Coupling pieces<br>KSG/KSZ | For compensating radial deviations                                    | 17              |



## Fluidic Muscle DMSP, with press-fitted connections

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Type codes

|                            |                              |      |   |    |   |      |   |    |   |    |
|----------------------------|------------------------------|------|---|----|---|------|---|----|---|----|
|                            |                              | DMSP | - | 10 | - | 500N | - | RM | - | CM |
| <b>Drive function</b>      |                              |      |   |    |   |      |   |    |   |    |
| Single-acting, pulling     |                              |      |   |    |   |      |   |    |   |    |
| DMSP                       | Fluidic Muscle               |      |   |    |   |      |   |    |   |    |
| <b>Internal dia. [mm]</b>  |                              |      |   |    |   |      |   |    |   |    |
| <b>Nominal length [mm]</b> |                              |      |   |    |   |      |   |    |   |    |
| ...N                       | 40 ... 9000                  |      |   |    |   |      |   |    |   |    |
| <b>First connection</b>    |                              |      |   |    |   |      |   |    |   |    |
| RM                         | Pneumatic connection, radial |      |   |    |   |      |   |    |   |    |
| AM                         | Pneumatic connection, axial  |      |   |    |   |      |   |    |   |    |
| <b>Second connection</b>   |                              |      |   |    |   |      |   |    |   |    |
| RM                         | Pneumatic connection, radial |      |   |    |   |      |   |    |   |    |
| AM                         | Pneumatic connection, axial  |      |   |    |   |      |   |    |   |    |
| CM                         | No pneumatic connection      |      |   |    |   |      |   |    |   |    |

# Fluidic Muscle DMSP, with press-fitted connections

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Technical data

-  Size  
10 ... 40 mm
-  Nominal length  
40 ... 9000 mm
-  Lifting force  
0 ... 6000 N



| General technical data                       |                                                                                                  |                          |                      |
|----------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------|----------------------|
| Size                                         | 10                                                                                               | 20                       | 40                   |
| Pneumatic connection                         | G1/8                                                                                             | G1/4                     | G3/8                 |
| Design                                       | Contraction membrane                                                                             |                          |                      |
| Mode of operation                            | Single-acting, pulling                                                                           |                          |                      |
| Internal dia. [mm]                           | 10                                                                                               | 20                       | 40                   |
| Nominal length [mm]                          | 40 ... 9000                                                                                      | 60 ... 9000              | 120 ... 9000         |
| Max. additional load, freely suspended [kg]  | 30                                                                                               | 80                       | 250                  |
| Max. permissible pretensioning <sup>1)</sup> | 3% of nominal length                                                                             | 4% of nominal length     | 5% of nominal length |
| Max. permissible contraction                 | 25% of nominal length                                                                            |                          |                      |
| Max. hysteresis                              | ≤ 3% of nominal length                                                                           | ≤ 2.5% of nominal length |                      |
| Max. relaxation                              | ≤ 3% of nominal length                                                                           |                          |                      |
| Repetition accuracy                          | ≤ 1% of nominal length                                                                           |                          |                      |
| Max. perm. offset of connections             | Angle tolerance: ≤ 1.0°                                                                          |                          |                      |
|                                              | Parallelism tolerance: ± 0.5% (up to 400 mm nominal length), ≤ 2 mm (from 400 mm nominal length) |                          |                      |
| Type of mounting                             | With accessories                                                                                 |                          |                      |
| Assembly position                            | Any (an external guide is required if lateral forces occur)                                      |                          |                      |

1) The max. pretensioning is achieved when the max. permissible freely suspended useful load is attached.

| Operating and environmental conditions       |                                                                                |         |    |
|----------------------------------------------|--------------------------------------------------------------------------------|---------|----|
| Size                                         | 10                                                                             | 20      | 40 |
| Operating pressure [bar]                     | 0 ... 8                                                                        | 0 ... 6 |    |
| Operating medium                             | Filtered compressed air, lubricated or unlubricated (other media upon request) |         |    |
| Ambient temperature [°C]                     | -5 ... +60                                                                     |         |    |
| Corrosion resistance class CRC <sup>2)</sup> | 2                                                                              |         |    |

2) Corrosion resistance class 2 according to Festo standard 940 070  
Components requiring moderate corrosion resistance. Externally visible parts with primarily decorative surface requirements which are in direct contact with a normal industrial environment or media such as coolants or lubricating agents.

| Forces [N] at max. permissible operating pressure |     |      |      |
|---------------------------------------------------|-----|------|------|
| Size                                              | 10  | 20   | 40   |
| Theoretical force                                 | 630 | 1500 | 6000 |

## Fluidic Muscle DMSP, with press-fitted connections

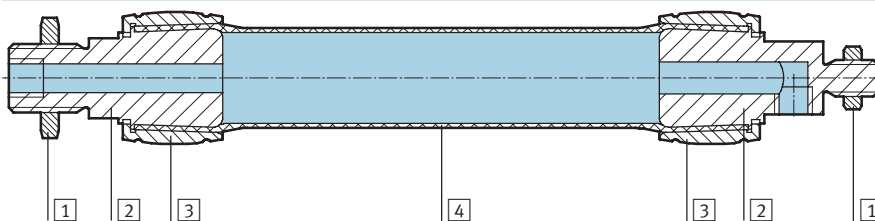
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Technical data

| Weight [g]                       |       |    |     |     |
|----------------------------------|-------|----|-----|-----|
| Size                             |       | 10 | 20  | 40  |
| Basic weight at 0 m length       | RM-CM | 58 | 169 | 675 |
|                                  | RM-RM | 66 | 182 | 707 |
|                                  | RM-AM | 75 | 202 | 767 |
|                                  | AM-CM | 66 | 189 | 735 |
|                                  | AM-AM | 83 | 222 | 827 |
| Additional weight per 1 m length |       | 94 | 178 | 340 |

### Materials

Sectional view



| Fluidic muscle |                                         |
|----------------|-----------------------------------------|
| 1 Nut          | Galvanised steel                        |
| 2 Flange       | Wrought aluminium alloy, clear anodised |
| 3 Sleeve       | Wrought aluminium alloy, clear anodised |
| 4 Membrane     | Chloroprene, aramide                    |

# Fluidic Muscle DMSP, with press-fitted connections

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Technical data

## Permissible force $F$ [N] as a function of the contraction $h$ [%] of the nominal length

Force/displacement diagrams and sizing ranges

The limit for “freely suspended” loads is derived from the contraction. With the Fluidic Muscle DMSP-10-..., a

loosely attached additional load of 30 kg results in 3% pretensioning (see diagram). The limits specified in the

technical data must be complied with when using the fluidic muscle. The diagrams below illustrate the operat-

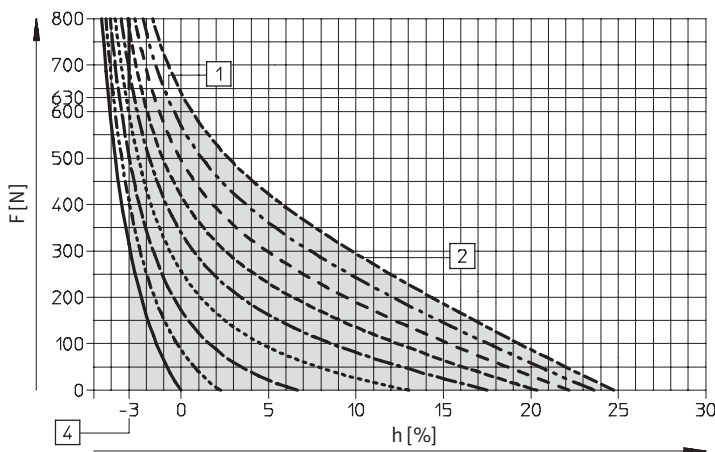
ing range of the fluidic muscle, depending on the diameter, within the boundary lines illustrated below.

### Using the diagrams

1. The upper limit of the grey area describes the minimum theoretical force at maximum operating pressure.
2. The right limiting curve of the grey area describes the maximum permissible operating pressure.
3. The right vertical limit of the grey area describes the maximum permissible contraction.
4. The left limit of the grey area describes the load limit of the muscle defined by the maximum pretensioning.

### Operating range DMSP-10-100N-...

Sizing examples → 32



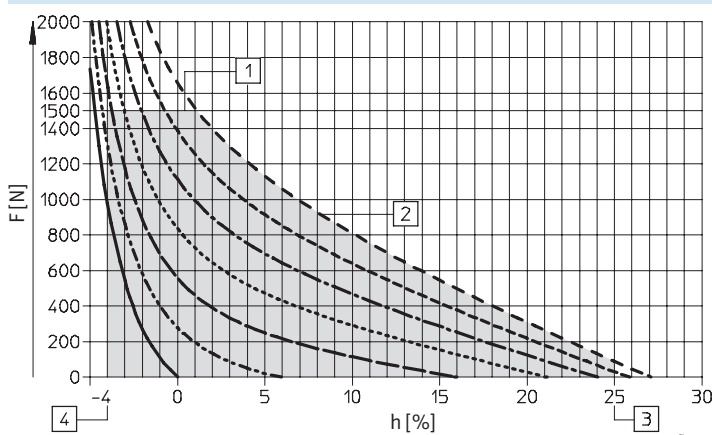
- 0 bar
- 1 bar
- 2 bar
- 3 bar
- 4 bar
- 5 bar
- 6 bar
- 7 bar
- 8 bar

- 1 Min. theoretical force at max. operating pressure
- 2 Max. operating pressure
- 4 Max. pretensioning

Permissible operating range

### Operating range DMSP-20-200N-...

Sizing examples → 32



- 0 bar
- 1 bar
- 2 bar
- 3 bar
- 4 bar
- 5 bar
- 6 bar

- 1 Min. theoretical force at max. operating pressure
- 2 Max. operating pressure
- 3 Max. deformation
- 4 Max. pretensioning

Permissible operating range

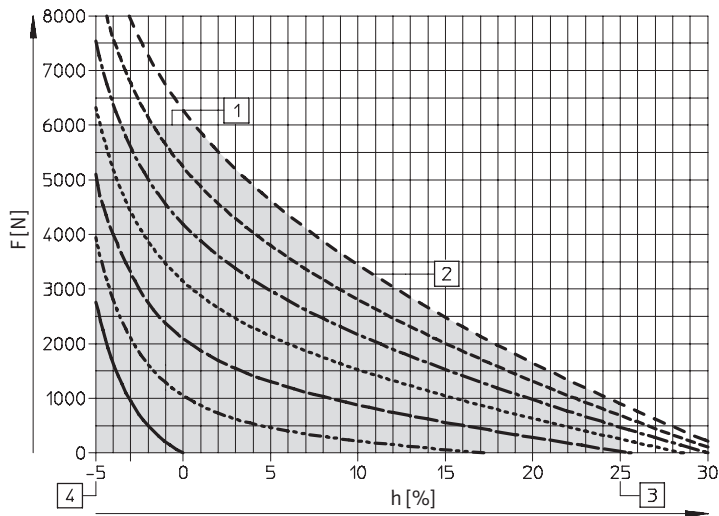
# Fluidic Muscle DMSP, with press-fitted connections

Technical data

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Operating range DMSP-40-400N-...

Sizing examples → 32



— 0 bar  
 - - - 1 bar  
 - - - 2 bar  
 - - - 3 bar  
 - - - 4 bar  
 - - - 5 bar  
 - - - 6 bar

1 Min. theoretical force at max. operating pressure  
 2 Max. operating pressure  
 3 Max. deformation  
 4 Max. pretensioning  
 Permissible operating range

## Note

The diagrams were determined using muscles with standard length (standard length = 10x internal dia.), sizing should therefore be carried out using the Fluidic Muscle sizing software. The software is available at

the address → [www.festo.com](http://www.festo.com). Approximate sizing is possible using the force/displacement diagram. Properties that influence the dependence between force and displacement, such

as material properties, manufacturing deviations and nominal length, are not taken into account in these diagrams. The theoretical force can therefore increase by up to ten per

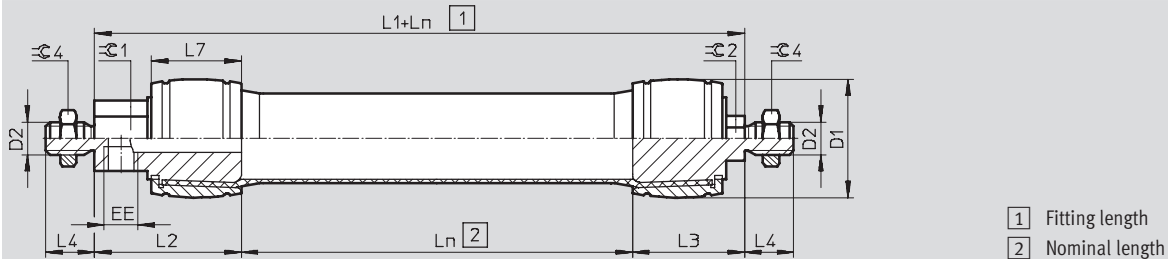
cent. Deviations can be compensated by means of pressure adaptation up to the maximum permissible operating pressure.

### Technical data

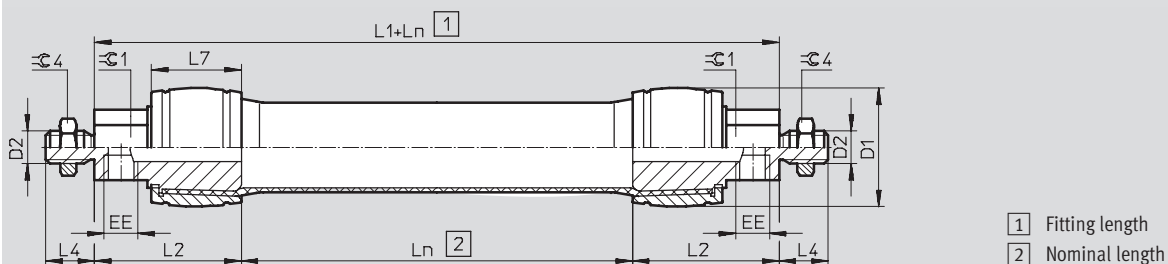
## Dimensions

Download CAD data → [www.festo.com](http://www.festo.com)

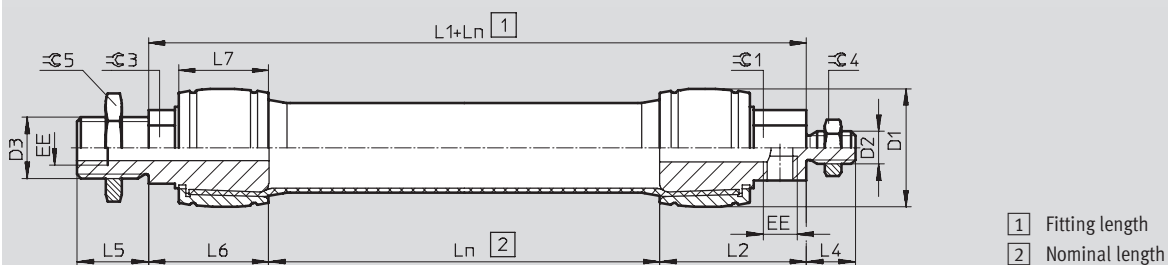
RM-CM – pneumatic connection, radial, at one end



RM-RM – pneumatic connection, radial, at both ends



AM-RM – pneumatic connection, axial and radial



| Size | D1   | D2       | D3      | EE <sup>2)</sup>              | Ln <sup>1)</sup> |      | L1    |       |       | L2   |
|------|------|----------|---------|-------------------------------|------------------|------|-------|-------|-------|------|
|      | max. |          |         |                               | min.             | max. | RM-CM | RM-RM | AM-RM |      |
| 10   | 22   | M8       | M16x1.5 | G <sup>1</sup> / <sub>8</sub> | 40               | 9000 | 62    | 72    | 63    | 36   |
| 20   | 35   | M10x1.25 | M20x1.5 | G <sup>1</sup> / <sub>4</sub> | 60               |      | 95    | 113   | 97    | 56.5 |
| 40   | 57   | M16x1.5  | M30x1.5 | G <sup>3</sup> / <sub>8</sub> | 120              |      | 127   | 144   | 131   | 72   |

| Size | L3   | L4 | L5 | L6   | L7 | $\approx \mathfrak{E}1^{(2)}$ | $\approx \mathfrak{E}2^{(2)}$ | $\approx \mathfrak{E}3^{(2)}$ | $\approx \mathfrak{E}4$ | $\approx \mathfrak{E}5$ |
|------|------|----|----|------|----|-------------------------------|-------------------------------|-------------------------------|-------------------------|-------------------------|
| 10   | 26   | 15 | 16 | 27   | 19 | 14                            | 10                            | 17                            | 13                      | 24                      |
| 20   | 38.5 | 20 | 18 | 40.5 | 30 | 19                            | 12                            | 20                            | 17                      | 30                      |
| 40   | 55   | 24 | 35 | 59   | 44 | 30                            | 19                            | 30                            | 24                      | 46                      |

1) Tolerance  $< 100 \text{ mm} \pm 1 \text{ mm}$ ,  $100 \dots 400 \text{ mm} \pm 1\%$ ,  $> 400 \text{ mm} \pm 4 \text{ mm}$ .

- 1) tolerance < 100 mm  $\pm 1$  mm, 100 ... 400 mm  $\pm 1\%$ , > 400 mm  $\pm 4$  mm.
- 2) Parallel orientation of the spanner flats on the left and right connection side can lead to deviations (for production reasons).

# Fluidic Muscle DMSP, with press-fitted connections

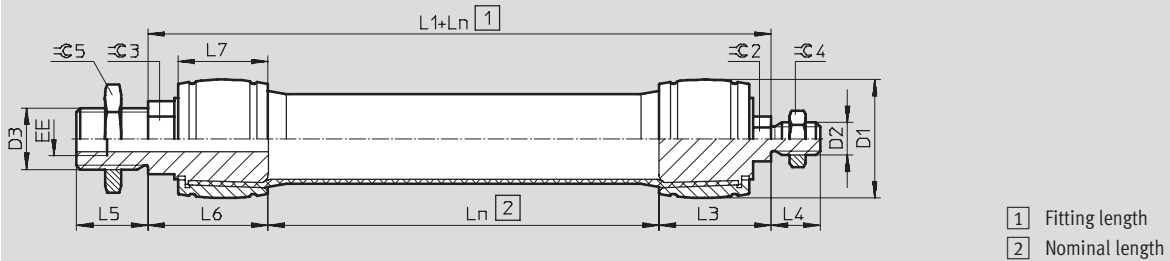
Technical data

**FESTO**

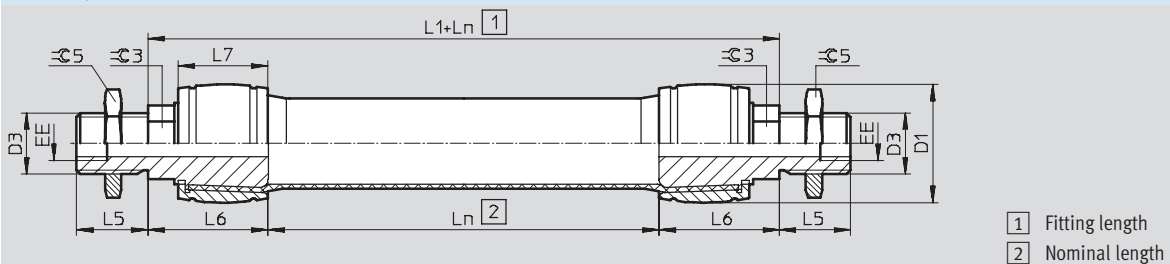
## Dimensions

Download CAD data → [www.festo.com](http://www.festo.com)

AM-CM – pneumatic connection, axial, at one end



AM-AM – pneumatic connection, axial, at both ends



| Size | D1<br>max. | D2       | D3      | EE              | Ln <sup>1)</sup> |      | L1    |       | L3   |
|------|------------|----------|---------|-----------------|------------------|------|-------|-------|------|
|      |            |          |         |                 | min.             | max. | AM-CM | AM-AM |      |
| 10   | 22         | M8       | M16x1.5 | G $\frac{1}{8}$ | 40               | 9000 | 53    | 54    | 26   |
| 20   | 35         | M10x1.25 | M20x1.5 | G $\frac{1}{4}$ | 60               |      | 79    | 81    | 38.5 |
| 40   | 57         | M16x1.5  | M30x1.5 | G $\frac{3}{8}$ | 120              |      | 114   | 118   | 55   |

| Size | L4 | L5 | L6   | L7 | ≈C <sup>1)2)</sup> | ≈C <sup>2)2)</sup> | ≈C <sup>3)2)</sup> | ≈C <sup>4)</sup> | ≈C <sup>5)</sup> |
|------|----|----|------|----|--------------------|--------------------|--------------------|------------------|------------------|
| 10   | 15 | 16 | 27   | 19 | 17                 | 10                 | 17                 | 13               | 24               |
| 20   | 20 | 18 | 40.5 | 30 | 19                 | 12                 | 20                 | 17               | 30               |
| 40   | 24 | 35 | 59   | 44 | 30                 | 19                 | 30                 | 24               | 46               |

1) Tolerance < 100 mm ±1 mm, 100 ... 400 mm ±1%, > 400 mm ±4 mm.

2) Parallel orientation of the spanner flats on the left and right connection side can lead to deviations (for production reasons).

# Fluidic Muscle DMSP, with press-fitted connections

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Ordering data – Modular products

| M Mandatory data |          |      |                |                  |                   |
|------------------|----------|------|----------------|------------------|-------------------|
| Module No.       | Function | Size | Nominal length | First connection | Second connection |
| 541 403          | DMSP     | 10   | 40 ... 9 000   | RM               | CM                |
| 541 404          |          | 20   |                | AM               | RM                |
| 541 405          |          | 40   |                |                  | AM                |
| Ordering example |          |      |                |                  |                   |
| 541 404          | DMSP     | - 20 | - 5 000 N      | - AM             | - RM              |

| Ordering table      |                                              |                            |                           |                 |       |               |
|---------------------|----------------------------------------------|----------------------------|---------------------------|-----------------|-------|---------------|
| Size                | 10                                           | 20                         | 40                        | Condi-<br>tions | Code  | Enter<br>code |
| M Module No.        | 541 403                                      | 541 404                    | 541 405                   |                 |       |               |
| Function            | Fluidic Muscle with press-fitted connections |                            |                           |                 | DMSP  | DMSP          |
| Size [mm]           | 10                                           | 20                         | 40                        |                 | -...  |               |
| Nominal length [mm] | 40 ... 9000                                  | 60 ... 9000                | 120 ... 9000              |                 | -...N | -...N         |
| First connection    | Radial, male thread                          |                            |                           |                 | -RM   |               |
|                     | Connecting thread / supply port              |                            |                           |                 |       |               |
|                     | M8 / G $\frac{1}{8}$                         | M10x1.25 / G $\frac{1}{4}$ | M16x1.5 / G $\frac{3}{8}$ |                 |       |               |
|                     | Axial, male thread                           |                            |                           |                 | -AM   |               |
| Second connection   | Closed, male thread                          |                            |                           |                 | -CM   |               |
|                     | Connecting thread                            |                            |                           |                 |       |               |
|                     | M8                                           | M10x1.25                   | M16x1.5                   |                 |       |               |
|                     | Radial, male thread                          |                            |                           |                 | -RM   |               |
|                     | Connecting thread / supply port              |                            |                           |                 |       |               |
|                     | M8 / G $\frac{1}{8}$                         | M10x1.25 / G $\frac{1}{4}$ | M16x1.5 / G $\frac{3}{8}$ |                 |       |               |
|                     | Axial, male thread                           |                            |                           |                 | -AM   |               |
|                     | Connecting thread / supply port              |                            |                           |                 |       |               |
|                     | M16x1.5 / G $\frac{1}{8}$                    | M20x1.5 / G $\frac{1}{4}$  | M30x1.5 / G $\frac{3}{8}$ |                 |       |               |

Transfer order code

|  |      |   |  |   |       |   |  |   |  |
|--|------|---|--|---|-------|---|--|---|--|
|  | DMSP | - |  | - | ... N | - |  | - |  |
|--|------|---|--|---|-------|---|--|---|--|



# Fluidic Muscle DMSP, with press-fitted connections

Accessories

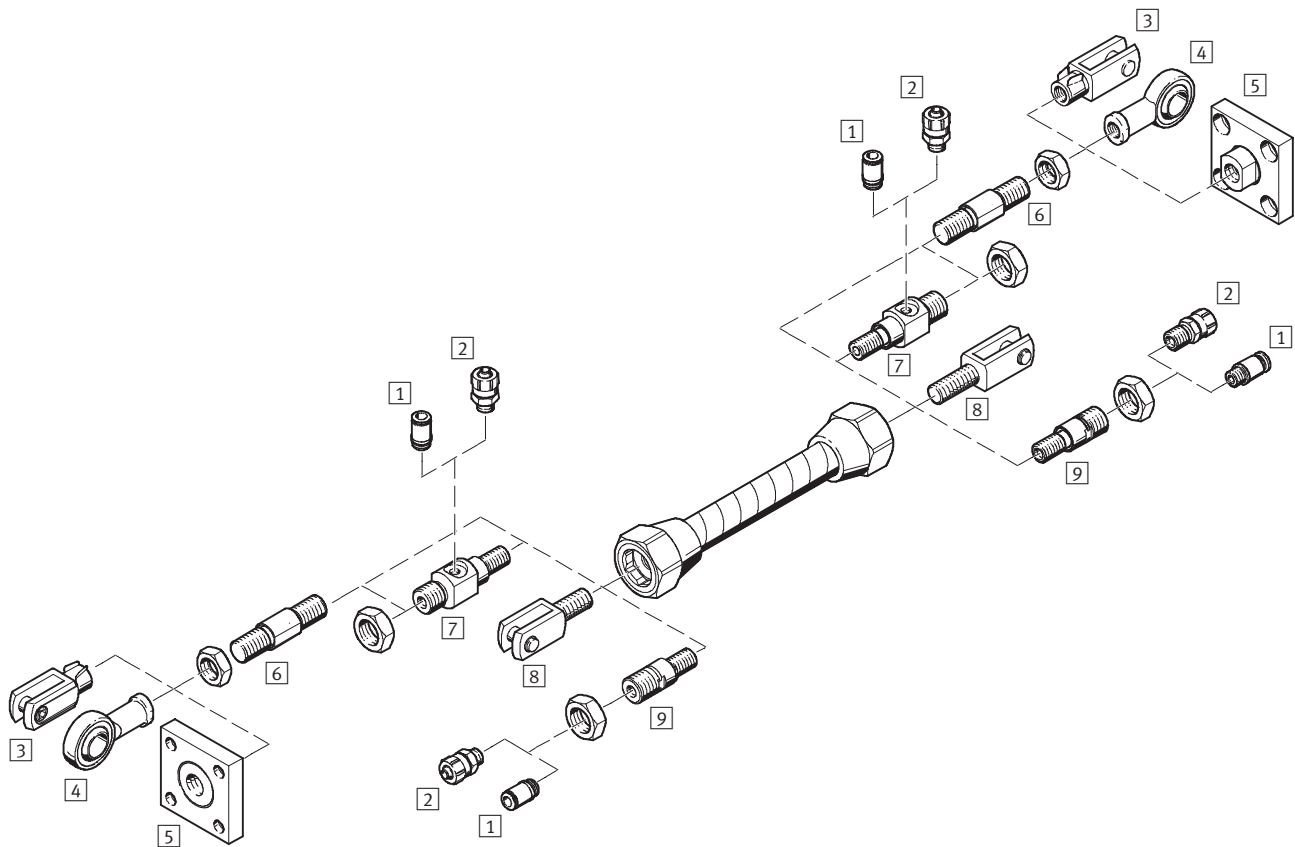
**FESTO**

| Ordering data                                                                     |          |          |              | Technical data → piston rod attachment                                            |          |          |              |
|-----------------------------------------------------------------------------------|----------|----------|--------------|-----------------------------------------------------------------------------------|----------|----------|--------------|
| Designation                                                                       | For size | Part No. | Type         | Designation                                                                       | For size | Part No. | Type         |
| Rod eye SGS                                                                       |          |          |              | Coupling piece KSG                                                                |          |          |              |
|  | 10       | 9 255    | SGS-M8       |  | 10       | –        |              |
|                                                                                   | 20       | 9 261    | SGS-M10x1,25 |                                                                                   | 20       | 32 963   | KSG-M10x1,25 |
|                                                                                   | 40       | 9 263    | SGS-M16x1,5  |                                                                                   | 40       | 32 965   | KSG-M16x1,5  |
| Rod clevis SG                                                                     |          |          |              | Coupling piece KSZ                                                                |          |          |              |
|  | 10       | 3 111    | SG-M8        |  | 10       | 36 124   | KSZ-M8       |
|                                                                                   | 20       | 6 144    | SG-M10x1,25  |                                                                                   | 20       | 36 125   | KSZ-M10x1,25 |
|                                                                                   | 40       | 6 146    | SG-M16x1,5   |                                                                                   | 40       | 36 127   | KSZ-M16x1,5  |

# Fluidic Muscle MAS, with screwed connections

Peripherals overview

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| Mounting attachments and accessories |                                                                         |                 |
|--------------------------------------|-------------------------------------------------------------------------|-----------------|
|                                      | Brief description                                                       | → Page/Internet |
| 1 Push-in fittings<br>QS             | For connecting compressed air tubing with standard external diameters   | quick star      |
| 2 Quick connectors<br>CK             | For connecting compressed air tubing with standard internal diameters   | ck              |
| 3 Rod clevis<br>SG                   | Permits a swivelling movement of the fluidic muscle in one plane        | 31              |
| 4 Rod eye<br>SGS                     | With spherical bearing                                                  | 31              |
| 5 Coupling pieces<br>KSG/KSZ         | For compensating radial deviations                                      | 31              |
| 6 Threaded rod<br>MXAD-T             | For connecting drive accessories                                        | 31              |
| 7 Radial adapter<br>MXAD-R           | For connecting drive accessories and the air supply in radial direction | 30              |
| 8 Rod clevis<br>SGA                  | With male thread for direct mounting on fluidic muscle                  | 31              |
| 9 Axial adapter<br>MXAD-A            | For connecting drive accessories and the air supply in axial direction  | 30              |

## 20.Fluidic Muscle MAS, with screwed connections

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Type codes

|                                   |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
|-----------------------------------|---------------------------------------------------------|-----|---|----|---|------|---|----|---|----|---|---|---|----|---|----|
|                                   |                                                         | MAS | - | 10 | - | 500N | - | AA | - | MC | - | K | - | ER | - | EG |
| <b>Drive function</b>             |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| Single-acting, pulling            |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| MAS                               | Fluidic Muscle                                          |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Internal dia. [mm]</b>         |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Nominal length [mm]</b>        |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| ...N                              | 40 ... 9000                                             |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Material</b>                   |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| AA                                | Standard material (chloroprene, aramide)                |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Connection type</b>            |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| MC                                | Open at one end                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| MO                                | Open at both ends                                       |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Connection type</b>            |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| K                                 | With force compensator                                  |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| O                                 | Without force compensator                               |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| <b>Accessories supplied loose</b> |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| Adapter                           |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| ER                                | 1 adapter for radial air supply, at one end             |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| EA                                | 1 adapter for axial air supply, at one end              |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| BR                                | 2 adapters for radial air supply, at both ends          |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| BA                                | 2 adapters for axial air supply, at both ends           |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| RA                                | 1 adapter for radial and 1 adapter for axial air supply |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| Mounting                          |                                                         |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| EG                                | 1 threaded rod for mounting, at one end                 |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |
| BG                                | 2 threaded rods for mounting, at both ends              |     |   |    |   |      |   |    |   |    |   |   |   |    |   |    |

# Fluidic Muscle MAS, with screwed connections

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Technical data

-  Size  
10 ... 40 mm
-  Nominal length  
40 ... 9000 mm
-  Lifting force  
0 ... 6000 N



| General technical data                       |                           |                                                             |                          |                        |
|----------------------------------------------|---------------------------|-------------------------------------------------------------|--------------------------|------------------------|
| Size                                         |                           | 10                                                          | 20                       | 40                     |
| Pneumatic connection                         |                           | ➔ Adapter MXAD-... from page 30                             |                          |                        |
| Design                                       |                           | Contraction diaphragm                                       |                          |                        |
| Mode of operation                            |                           | Single-acting, pulling                                      |                          |                        |
| Internal dia.                                | [mm]                      | 10                                                          | 20                       | 40                     |
| Nominal length                               | [mm]                      | 40 ... 9000                                                 | 60 ... 9000              | 120 ... 9000           |
| Max. additional load, freely suspended       | [kg]                      | 30                                                          | 80                       | 250                    |
| Max. permissible pretensioning <sup>1)</sup> | Without force compensator | 3% of nominal length                                        | 4% of nominal length     | 5% of nominal length   |
|                                              | With force compensator    | 3% of nominal length                                        | 3% of nominal length     | 3% of nominal length   |
| Max. permissible contraction                 |                           | 25% of nominal length                                       |                          |                        |
| Max. hysteresis                              |                           | ≤ 3% of nominal length                                      | ≤ 2.5% of nominal length |                        |
| Max. relaxation                              |                           | ≤ 4% of nominal length                                      |                          | ≤ 3% of nominal length |
| Repetition accuracy                          |                           | ≤ 1% of nominal length                                      |                          |                        |
| Type of mounting                             |                           | With accessories                                            |                          |                        |
| Assembly position                            |                           | Any (an external guide is required if lateral forces occur) |                          |                        |

1) The max. pretensioning is achieved when the max. permissible freely suspended useful load is attached.

| Operating and environmental conditions       |                                                                                |         |    |
|----------------------------------------------|--------------------------------------------------------------------------------|---------|----|
| Size                                         | 10                                                                             | 20      | 40 |
| Operating pressure [bar]                     | 0 ... 8                                                                        | 0 ... 6 |    |
| Operating medium                             | Filtered compressed air, lubricated or unlubricated (other media upon request) |         |    |
| Ambient temperature [°C]                     | −5 ... +60                                                                     |         |    |
| Corrosion resistance class CRC <sup>2)</sup> | 2                                                                              |         |    |

2) Corrosion resistance class 2 according to Festo standard 940 070  
Components requiring moderate corrosion resistance. Externally visible parts with primarily decorative surface requirements which are in direct contact with a normal industrial environment or media such as coolants or lubricating agents.

| Forces [N] at max. permissible operating pressure |     |      |      |
|---------------------------------------------------|-----|------|------|
| Size                                              | 10  | 20   | 40   |
| Theoretical force                                 | 630 | 1500 | 6000 |
| Force compensation                                | 400 | 1200 | 4000 |

## Fluidic Muscle MAS, with screwed connections

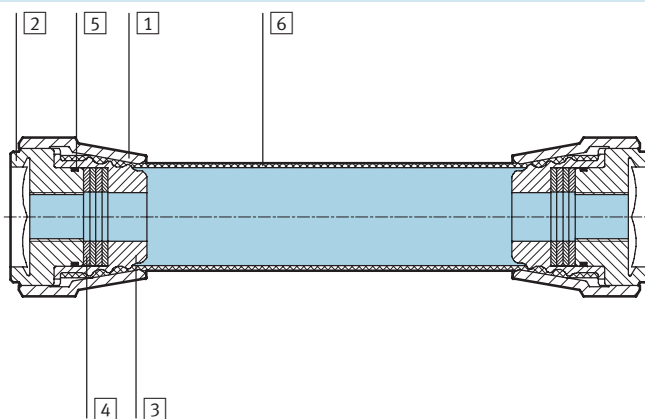
FESTO

Technical data

| Weight [g]                           |    |    |     |     |
|--------------------------------------|----|----|-----|-----|
| Size                                 |    | 10 | 20  | 40  |
| Basic weight at 0 m length           |    | 77 | 238 | 673 |
| Additional weight per 1 m length     |    | 94 | 178 | 340 |
| Connection without force compensator | MO | 38 | 114 | 331 |
|                                      | MC | 39 | 124 | 342 |
| Connection with force compensator    | MO | 49 | 153 | 521 |
|                                      | MC | 49 | 153 | 521 |

### Materials

Sectional view



| Fluidic muscle    |                |                                         |
|-------------------|----------------|-----------------------------------------|
| 1                 | Union nuts     | Wrought aluminium alloy, clear anodised |
| 2                 | Flange         | Wrought aluminium alloy, blue anodised  |
| 3                 | Internal cone  | Wrought aluminium alloy, clear anodised |
| 4                 | Cup springs    | Steel                                   |
| 5                 | Sealing ring   | Nitrile rubber                          |
| 6                 | Diaphragm hose | Chloroprene, aramide                    |
| –                 | Adhesive       | Loctite 243 (thread locking agent)      |
| –                 | Lubricant      | Klüberplex BE 31-102                    |
| Note on materials |                | Copper, PTFE and silicone-free          |

# Fluidic Muscle MAS, with screwed connections

FESTO

Technical data

## Permissible force $F$ [N] as a function of the contraction $h$ [%] of the nominal length

The limit for "freely suspended" loads is derived from the contraction. With the Fluidic Muscle MAS-10-..., a

loosely attached additional load of 30 kg results in 3% pretensioning (see diagram). The limits specified in the

technical data must be complied with when using the fluidic muscle. The diagrams below illustrate the operat-

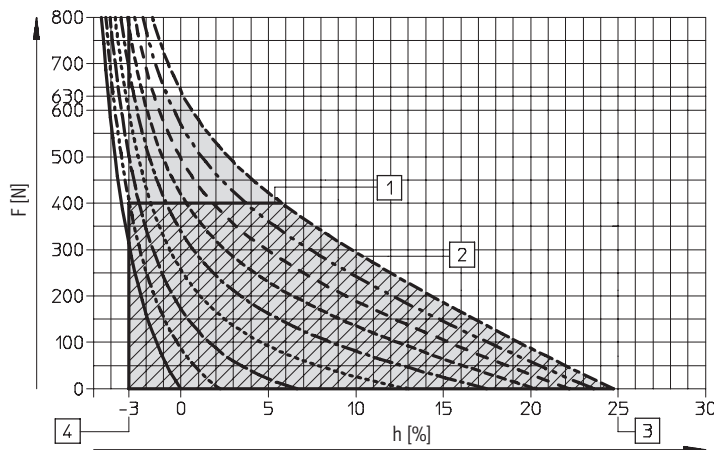
ing range of the fluidic muscle, depending on the diameter, within the boundary lines illustrated below.

### Using the diagrams

1. The upper limit of the hatched operating range describes the maximum theoretical force when using the force compensator.
2. The right limiting curve of the permissible operating ranges describes the maximum permissible operating pressure.
3. The right vertical limit of the permissible operating ranges describes the maximum permissible contraction.
4. The left limit of the permissible operating ranges describes the load limit of the muscle defined by the maximum pretensioning.

### Operating range MAS-10-100N-...

Sizing examples → 32



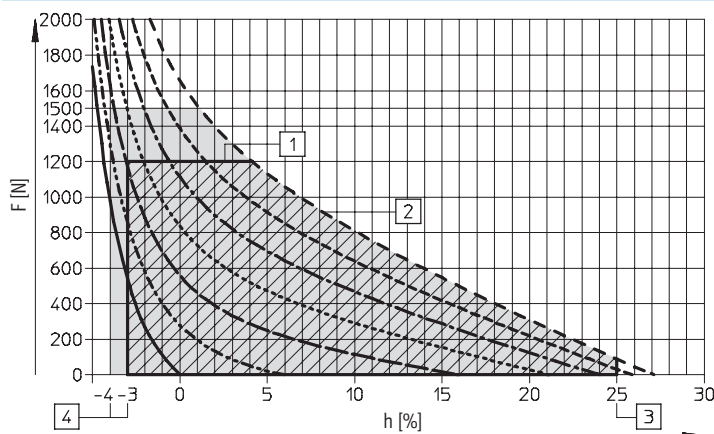
|       |           |
|-------|-----------|
| 0 bar | —————     |
| 1 bar | - - - - - |
| 2 bar | —————     |
| 3 bar | - - - - - |
| 4 bar | —————     |
| 5 bar | - - - - - |
| 6 bar | —————     |
| 7 bar | - - - - - |
| 8 bar | —————     |

- 1 Force compensation with MAS-10-...-K
- 2 Max. operating pressure
- 3 Max. deformation
- 4 Max. pretensioning

■ Permissible operating range for MAS-10-...  
 ▨ Permissible operating range for MAS-10-...-K

### Operating range MAS-20-200N-...

Sizing examples → 32



|       |           |
|-------|-----------|
| 0 bar | —————     |
| 1 bar | - - - - - |
| 2 bar | —————     |
| 3 bar | - - - - - |
| 4 bar | —————     |
| 5 bar | - - - - - |
| 6 bar | —————     |

- 1 Force compensation with MAS-20-...-K
- 2 Max. operating pressure
- 3 Max. deformation
- 4 Max. pretensioning

■ Permissible operating range for MAS-20-...  
 ▨ Permissible operating range for MAS-20-...-K

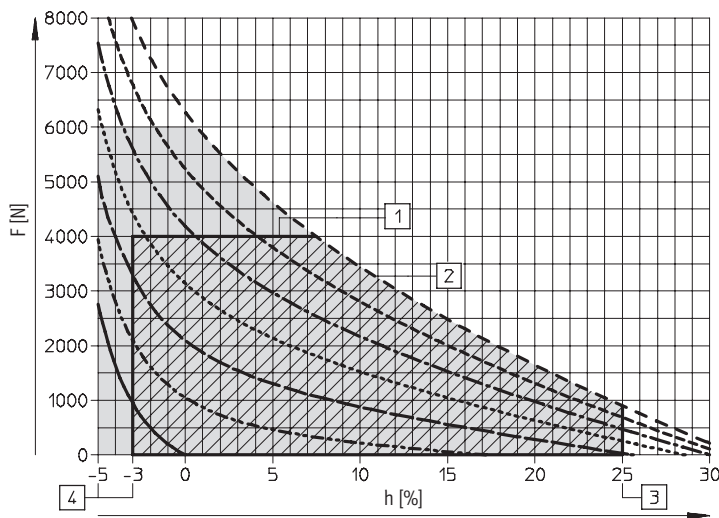
# Fluidic Muscle MAS, with screwed connections

Technical data

**FESTO**

Operating range MAS-40-400N-...

Sizing examples → 32



## Note

The specified pretensioning applies to the design without force compensation – the diagrams were determined using muscles with standard length (standard length = 10x internal dia.), sizing should therefore be carried out

using the Fluidic Muscle sizing software. The software is available at the address → [www.festo.com](http://www.festo.com). Approximate sizing is possible using the force/displacement diagram. Properties that influence the dependence

between force and displacement, such as material properties, manufacturing deviations and nominal length, are not taken into account in these diagrams. The theoretical force can

therefore increase by up to ten per cent. Deviations can be compensated by means of pressure adaptation up to the maximum permissible operating pressure.

# Fluidic Muscle MAS, with screwed connections

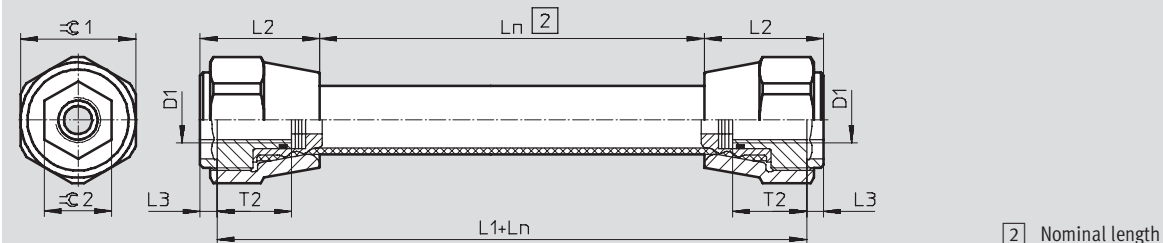
Technical data

**FESTO**

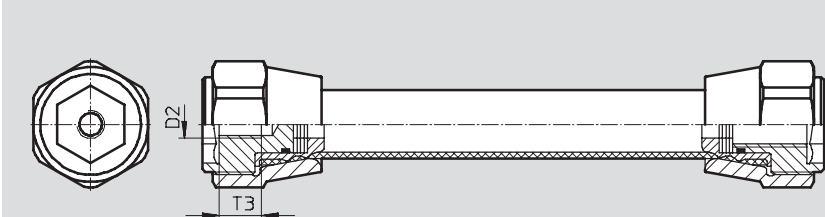
## Dimensions – without force compensation

Download CAD data → [www.festo.com](http://www.festo.com)

MO-O – open at both ends



MC-O – open at one end



| Size | D1       | D2       | Ln   |                    | L1   |
|------|----------|----------|------|--------------------|------|
|      |          |          | min. | max.               |      |
| 10   | M10x1.25 | M10x1.25 | 40   | 9000 <sup>1)</sup> | 60.2 |
| 20   | M16x1.5  | M10x1.25 | 60   |                    | 73   |
| 40   | M20x1.5  | M16x1.5  | 120  |                    | 95   |

| Size | L2   | L3 | T2   | T3 | $\varnothing 1$ | $\varnothing 2$ |
|------|------|----|------|----|-----------------|-----------------|
| 10   | 34.1 | 4  | 10   | 10 | 27              | 17              |
| 20   | 42.5 | 6  | 26.5 | 15 | 41              | 24              |
| 40   | 55.5 | 8  | 21.8 | 20 | 60              | 41              |

1) Tolerance ≤ 100 mm ±1 mm, 100 ... 400 mm ±1%, > 400 mm ±4 mm.



# Fluidic Muscle MAS, with screwed connections

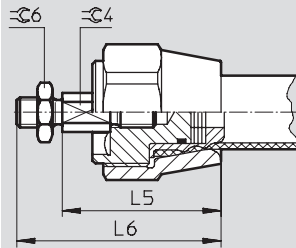
FESTO

Technical data

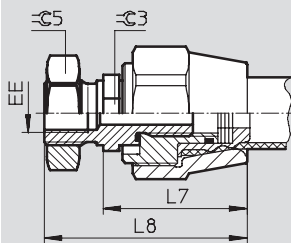
## Dimensions – without force compensation

Download CAD data → [www.festo.com](http://www.festo.com)

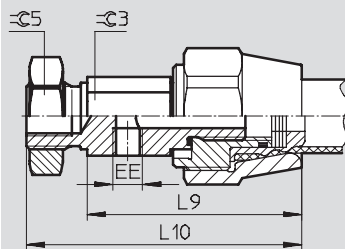
EG – open at one end, with threaded rod



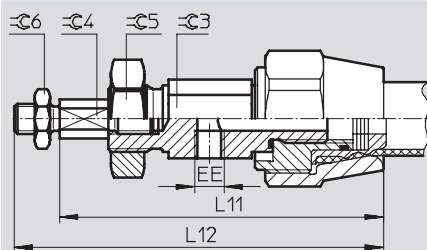
EA/BA – pneumatic connection, axial, one end/both ends



ER/BR – pneumatic connection, radial, one end/both ends



ER/BR-EG/BG – pneumatic connection, radial with threaded rod, one end/both ends



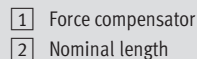
| Size | EE              |                 | L5   | L6   | L7   | L8  | L9   |
|------|-----------------|-----------------|------|------|------|-----|------|
|      | Axial           | Radial          |      |      |      |     |      |
| 10   | G $\frac{1}{8}$ | M5              | 46.1 | 61.1 | 42.6 | 60  | 58.2 |
| 20   | G $\frac{1}{4}$ | G $\frac{1}{8}$ | 52.5 | 67.5 | 49   | 69  | 71   |
| 40   | G $\frac{3}{8}$ | G $\frac{1}{4}$ | 67.5 | 91.5 | 63   | 101 | 93   |

| Size | L10  | L11  | L12   | G3 | G4 | G5 | G6 |
|------|------|------|-------|----|----|----|----|
| 10   | 75.6 | 96.6 | 111.6 | 17 | 11 | 24 | 17 |
| 20   | 91   | 107  | 122   | 24 | 11 | 32 | 17 |
| 40   | 131  | 151  | 175   | 36 | 17 | 46 | 24 |

## Technical data

Download CAD data → [www.festo.com](http://www.festo.com)

MO-K – open at both ends



| Size | L3 | L4  | T1 | T2   | T3 | $\approx \mathbb{G}1$ | $\approx \mathbb{G}2$ |
|------|----|-----|----|------|----|-----------------------|-----------------------|
| 10   | 4  | 2.5 | 15 | 10   | 10 | 27                    | 17                    |
| 20   | 6  | 5.5 | 24 | 26.5 | 15 | 41                    | 24                    |
| 40   | 8  | 6.5 | 30 | 21.8 | 20 | 60                    | 41                    |

1) Tolerance  $\leq 100 \text{ mm} \pm 1 \text{ mm}$ ,  $100 \dots 400 \text{ mm} \pm 1\%$ ,  $> 400 \text{ mm} \pm 4 \text{ mm}$ .

# Fluidic Muscle MAS, with screwed connections

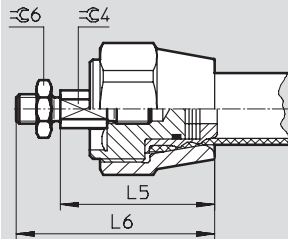
Technical data

**FESTO**

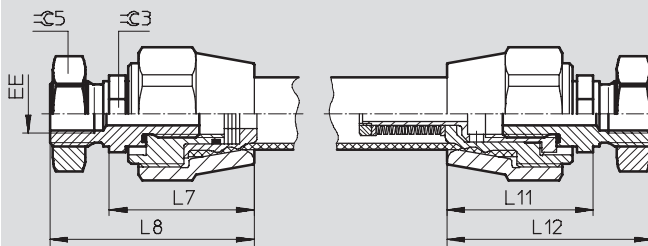
## Dimensions – without force compensation

Download CAD data → [www.festo.com](http://www.festo.com)

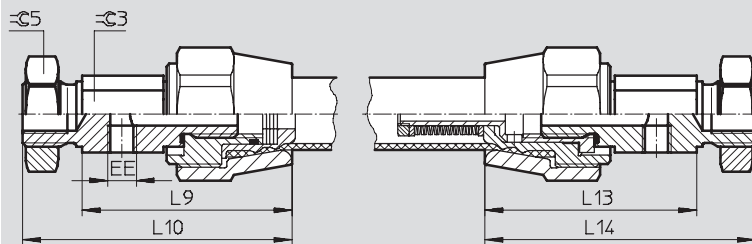
EG – open at one end, with threaded rod



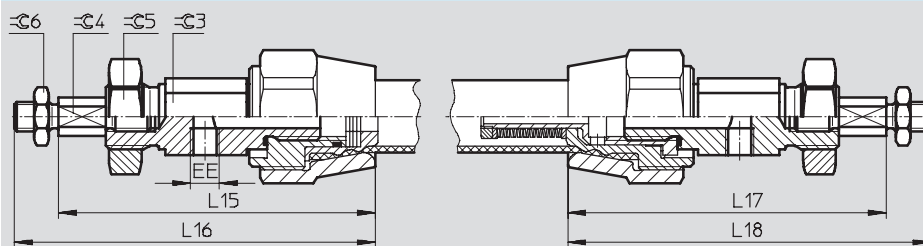
EA/BA – pneumatic connection, axial, one end/both ends



ER/BR – pneumatic connection, radial, one end/both ends



EA/BA-EG/BG – pneumatic connection, radial with threaded rod, one end/both ends



| Size | EE              |                 | L5   | L6   | L7   | L8  | L9   | L10  | L11  | L12   |
|------|-----------------|-----------------|------|------|------|-----|------|------|------|-------|
|      | Axial           | Radial          |      |      |      |     |      |      |      |       |
| 10   | G $\frac{1}{8}$ | M5              | 46.1 | 61.1 | 42.6 | 60  | 58.2 | 75.6 | 44.1 | 61.5  |
| 20   | G $\frac{1}{4}$ | G $\frac{1}{8}$ | 52.5 | 67.5 | 49   | 69  | 71   | 91   | 49.5 | 69.5  |
| 40   | G $\frac{3}{8}$ | G $\frac{1}{4}$ | 67.5 | 91.5 | 63   | 101 | 93   | 131  | 64.5 | 102.5 |

| Size | L13  | L14   | L15  | L16   | L17   | L18   | $\varnothing 3$ | $\varnothing 4$ | $\varnothing 5$ | $\varnothing 6$ |
|------|------|-------|------|-------|-------|-------|-----------------|-----------------|-----------------|-----------------|
| 10   | 59.7 | 77.1  | 96.6 | 111.6 | 98.1  | 113.1 | 17              | 11              | 24              | 17              |
| 20   | 71.5 | 91.5  | 107  | 122   | 107.5 | 122.5 | 24              | 11              | 32              | 17              |
| 40   | 94.5 | 132.5 | 151  | 175   | 152.5 | 176.6 | 36              | 17              | 46              | 24              |

## 29.Fluidic Muscle MAS, with screwed connections

Ordering data – Modular products

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| M Mandatory data |          |             |                |          |                 |                | O Options      |          |
|------------------|----------|-------------|----------------|----------|-----------------|----------------|----------------|----------|
| Module No.       | Function | Inside dia. | Nominal length | Material | Connection type | Connector type | Adapter        | Mounting |
| 534 201          | MAS      | 10          | ...N           | AA       | MC<br>MO        | K<br>O         | ER             | EG       |
| 534 202          |          | 20          |                |          |                 |                | EA             | BG       |
| 534 203          |          | 40          |                |          |                 |                | BR<br>BA<br>RA |          |
| Ordering example |          |             |                |          |                 |                |                |          |
| 534 201          | MAS      | - 10        | - 500N         | - AA     | - MC            | - K            | - ER           | - EG     |

| Ordering table             |                                                         |             |              |                 |       |               |     |
|----------------------------|---------------------------------------------------------|-------------|--------------|-----------------|-------|---------------|-----|
| Size                       | 10                                                      | 20          | 40           | Condi-<br>tions | Code  | Enter<br>code |     |
| M Module No.               | 534 201                                                 | 534 202     | 534 203      |                 |       |               |     |
| Function                   | Fluidic Muscle with screwed connections                 |             |              |                 | MAS   |               | MAS |
| Internal dia. [mm]         | 10                                                      | 20          | 40           |                 | -...  |               |     |
| Nominal length [mm]        | 40 ... 9000                                             | 60 ... 9000 | 120 ... 9000 |                 | -...N |               |     |
| Material                   | Standard material (chloroprene)                         |             |              |                 | -AA   |               | -AA |
| Connection type            | Fluidic Muscle open at one end                          |             |              |                 | -MC   |               |     |
|                            | Fluidic Muscle open at both ends                        |             |              |                 | -MO   |               |     |
| Connector type             | Screwed connections with force compensator              |             |              |                 | -K    |               |     |
|                            | Screwed connections without force compensator           |             |              |                 | -O    |               |     |
| O Adapters, supplied loose | 1 adapter for radial air supply, at one end             |             |              | 1               | -ER   |               |     |
|                            | 1 adapter for axial air supply, at one end              |             |              | 1               | -EA   |               |     |
|                            | 2 adapters for radial air supply, at both ends          |             |              | 2               | -BR   |               |     |
|                            | 2 adapters for axial air supply, at both ends           |             |              | 2               | -BA   |               |     |
|                            | 1 adapter for radial and 1 adapter for axial air supply |             |              | 2               | -RA   |               |     |
|                            |                                                         |             |              |                 |       |               |     |
| Mountings, supplied loose  | 1 threaded rod for mounting, at one end                 |             |              | 3               | -EG   |               |     |
|                            | 2 threaded rods for mounting, at both ends              |             |              | 4               | -BG   |               |     |

1 ER, EA Not in combination with connection type MO.

2 BR, BA, RA Not in combination with connection type MC.

3 EG In combination with connection type MO only permissible in combination with adapter BR, RA.

4 BG In combination with connection type MC only permissible in combination with adapter ER.

In combination with connection type MO only permissible in combination with adapter BR.

Transfer order code

|  |     |   |  |   |  |   |    |   |  |   |  |   |  |   |  |
|--|-----|---|--|---|--|---|----|---|--|---|--|---|--|---|--|
|  | MAS | - |  | - |  | - | AA | - |  | - |  | - |  | - |  |
|--|-----|---|--|---|--|---|----|---|--|---|--|---|--|---|--|

## 30.Fluidic Muscle MAS, with screwed connections

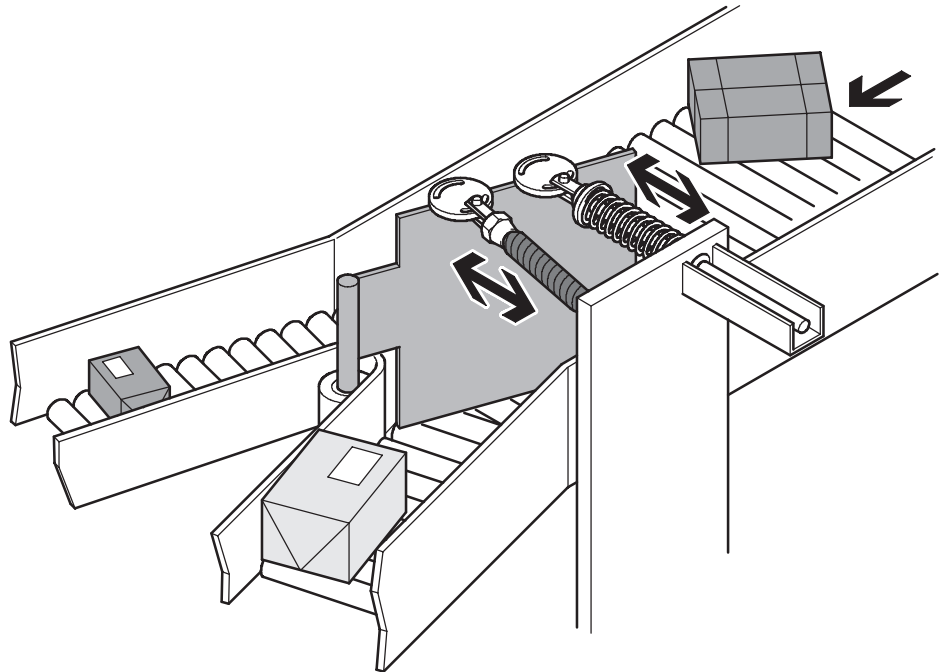
FESTO

Application example

### Force and dynamism

#### Drive for sorting

The ideal drive for sorting tasks and stop functions in delivery processes thanks to the muscle's high speed and good acceleration behaviour. The short response times mean that cycle rates can be increased considerably.



# Fluidic Muscle MAS, with screwed connections

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Accessories

## Axial adapter MXAD-A

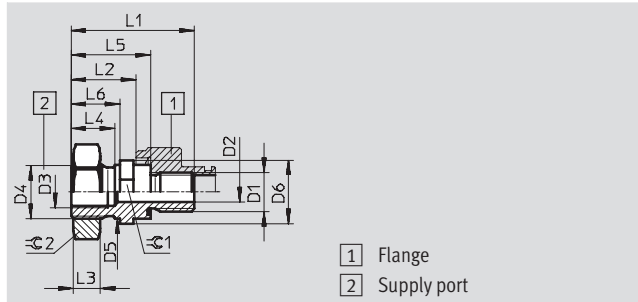
(order code EA/BA/RA)

Material:

Adapter: Anodised aluminium

Nut: Brass

Seal: Nitrile rubber



| Dimensions and ordering data |          |         |                 |         |                |         |      |      |    |
|------------------------------|----------|---------|-----------------|---------|----------------|---------|------|------|----|
| For size                     | D1       | D2<br>Ø | D3              | D4      | D5<br>Ø<br>h11 | D6<br>Ø | L1   | L2   | L3 |
| 10                           | M10x1.25 | 5       | G $\frac{1}{8}$ | M16x1.5 | 16             | 20      | 39.9 | 25.9 | 8  |
| 20                           | M16x1.5  | 8       | G $\frac{1}{4}$ | M22x1.5 | 22             | 26      | 50.5 | 26.5 | 11 |
| 40                           | M20x1.5  | 10      | G $\frac{3}{8}$ | M30x1.5 | 30             | 40      | 73.5 | 45.5 | 8  |

| For size | L4   | L5   | L6   | ≈C1 | ≈C2 | Weight<br>[g] | Part No. | Type     |
|----------|------|------|------|-----|-----|---------------|----------|----------|
| 10       | 15.4 | 29.9 | 17.4 | 17  | 24  | 33            | 534 400  | MXAD-A10 |
| 20       | 18   | 32.5 | 20   | 24  | 32  | 69            | 534 402  | MXAD-A16 |
| 40       | 35   | 53.5 | 38   | 36  | 46  | 184           | 534 404  | MXAD-A20 |

## Radial adapter MXAD-R

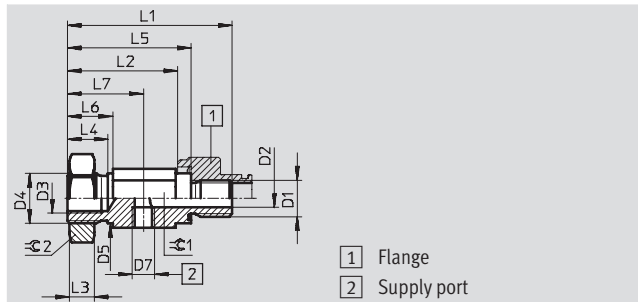
(order code ER/BR/RA)

Material:

Adapter: Anodised aluminium

Nut: Brass

Seal: Nitrile rubber



| Dimensions and ordering data |          |         |          |         |                |                 |       |      |    |
|------------------------------|----------|---------|----------|---------|----------------|-----------------|-------|------|----|
| For size                     | D1       | D2<br>Ø | D3       | D4      | D5<br>Ø<br>h11 | D7              | L1    | L2   | L3 |
| 10                           | M10x1.25 | 5       | M10x1.25 | M16x1.5 | 16             | M5              | 55.5  | 41.5 | 8  |
| 20                           | M16x1.5  | 8       | M10x1.25 | M22x1.5 | 22             | G $\frac{1}{8}$ | 72.5  | 48.5 | 11 |
| 40                           | M20x1.5  | 10      | M16x1.5  | M30x1.5 | 30             | G $\frac{1}{4}$ | 103.5 | 75.5 | 8  |

| For size | L4   | L5   | L6   | L7   | ≈C1 | ≈C2 | Weight<br>[g] | Part No. | Type     |
|----------|------|------|------|------|-----|-----|---------------|----------|----------|
| 10       | 15.4 | 45.5 | 17.4 | 26.7 | 17  | 24  | 44            | 534 401  | MXAD-R10 |
| 20       | 18   | 54.5 | 20   | 33.5 | 24  | 32  | 109           | 534 403  | MXAD-R16 |
| 40       | 35   | 83.5 | 38   | 56   | 36  | 46  | 263           | 534 405  | MXAD-R20 |

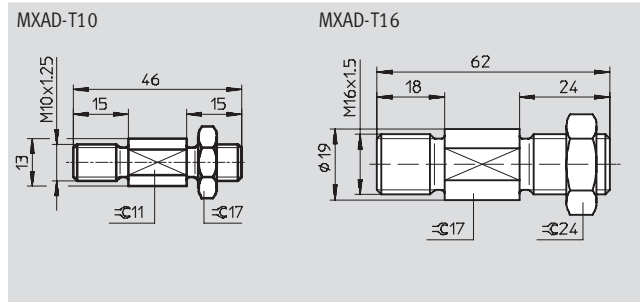
# Fluidic Muscle MAS, with screwed connections

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Accessories

## Threaded rod MXAD-T (order code EG/BG)

Material:  
Aluminium



| Dimensions and ordering data |                                  |               |          |          |
|------------------------------|----------------------------------|---------------|----------|----------|
| For size                     | Suitable for threaded connection | Weight<br>[g] | Part No. | Type     |
| 10/20                        | M10x1.25                         | 40            | 187 597  | MXAD-T10 |
| 40                           | M16x1.5                          | 140           | 187 609  | MXAD-T16 |

| Ordering data               |          |          |              | Technical data → piston rod attachment |          |          |              |
|-----------------------------|----------|----------|--------------|----------------------------------------|----------|----------|--------------|
| Designation                 | For size | Part No. | Type         | Designation                            | For size | Part No. | Type         |
| Rod eye SGS <sup>1)</sup>   |          |          |              | Coupling piece KSG <sup>1)</sup>       |          |          |              |
|                             | 10       | 9 261    | SGS-M10x1,25 |                                        | 10       | 32 963   | KSG-M10x1,25 |
|                             | 20       | 9 261    | SGS-M10x1,25 |                                        | 20       | 32 963   | KSG-M10x1,25 |
|                             | 40       | 9 263    | SGS-M16x1,5  |                                        | 40       | 32 965   | KSG-M16x1,5  |
| Rod clevis SGA              |          |          |              | Coupling piece KSZ <sup>1)</sup>       |          |          |              |
|                             | 10       | 32 954   | SGA-M10x1,25 |                                        | 10       | 36 125   | KSZ-M10x1,25 |
|                             | 20       | 32 954   | SGA-M10x1,25 |                                        | 20       | 36 125   | KSZ-M10x1,25 |
|                             | 40       | 10 768   | SGA-M16x1,5  |                                        | 40       | 36 127   | KSZ-M16x1,5  |
| Rod clevis SG <sup>1)</sup> |          |          |              |                                        |          |          |              |
|                             | 10       | 6 144    | SG-M10x1,25  |                                        |          |          |              |
|                             | 20       | 6 144    | SG-M10x1,25  |                                        |          |          |              |
|                             | 40       | 6 146    | SG-M16x1,5   |                                        |          |          |              |

1) Threaded rod MXAD-T... is required.

Note  
When replacing an existing Fluidic Muscle MAS and the corresponding mounting accessories → 7

# Fluidic Muscle DMSP/MAS

Sizing

FESTO

## Example 1

### Lifting a constant load

A Fluidic Muscle is to be used to engage free of forces with a constant load of 80 kg on a supporting surface and raise this a distance of 100 mm. The operating pressure is to be 6 bar.

The size (diameter and nominal length) of the fluidic muscle is to be found.



Note

The sizing should be performed using the Fluidic Muscle sizing software, as the diagrams describe only a muscle of standard length (standard length =

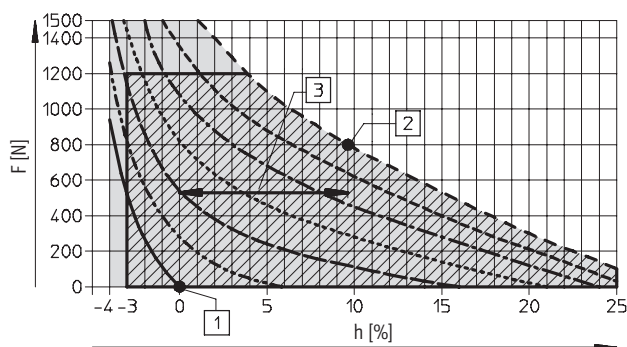
10x internal dia.). The software is available at the address  
→ [www.festo.com](http://www.festo.com).

The limits specified in the technical data must be complied with when using the muscle.

| General conditions                 | Values        |
|------------------------------------|---------------|
| Required force at rest             | 0 N           |
| Required stroke                    | 100 mm        |
| Required force in contracted state | approx. 800 N |
| Operating pressure                 | 6 bar         |

### Solution method

|                                                       |                                                                                                              |                                                                                                            |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Step 1</b><br>Determining the required muscle size | Determine the most suitable muscle diameter on the basis of the required force. The required force is 800 N. | MAS-20-... or MAS-40-... are available for selection.                                                      |
| <b>Step 2</b><br>Entering load point 1                | Load point 1 is entered into the force/displacement diagram for the MAS-20-...                               | Force $F = 0$ N<br>Pressure $p = 0$ bar                                                                    |
| <b>Step 3</b><br>Entering load point 2                | Load point 2 is entered into the force/displacement graph.                                                   | Force $F = 800$ N<br>Pressure $p = 6$ bar                                                                  |
| <b>Step 4</b><br>Reading the length change            | The change in the length of the muscle is read between the load points on the X axis (contraction in %).     | Result:<br>9.6% contraction.                                                                               |
| <b>Step 5</b><br>Calculating the nominal length       | The required nominal muscle length for a stroke of 100 mm is obtained by dividing by the contraction in %.   | Result:<br>$100 \text{ mm} / 9.6\% \sim 1042 \text{ mm}$ .                                                 |
| <b>Step 6</b><br>Result                               | A Fluidic Muscle with a nominal length of 1042 mm should be ordered.                                         | In order to attach a load of 80 kg free of forces and lift this 100 mm, a MAS-20-1042N-AA-... is required. |



|       |           |
|-------|-----------|
| 0 bar | —————     |
| 1 bar | - - - - - |
| 2 bar | - - - - - |
| 3 bar | - - - - - |
| 4 bar | - - - - - |
| 5 bar | - - - - - |
| 6 bar | - - - - - |

- 1 Load point 1
- 2 Load point 2
- 3 Length change = 9.6%



# Fluidic Muscle DMSP/MAS

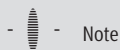
Sizing

## Example 2

Use as a tension spring

In this example, the muscle is to be used as a tension spring.

The size (diameter and nominal length) of the fluidic muscle is to be found.



Note

Sizing should be performed using the Fluidic Muscle sizing software, as the diagrams describe only a muscle of standard length (standard length =

10x internal dia.). The software is available at the address  
→ [www.festo.com](http://www.festo.com).

The limits specified in the technical data must be complied with when using the muscle.

| General conditions                 | Values |
|------------------------------------|--------|
| Required force in extended state   | 2000 N |
| Required force in contracted state | 1000 N |
| Required stroke (spring length)    | 50 mm  |
| Operating pressure                 | 2 bar  |

## Solution method

**Step 1**  
**Determining the required muscle size**

Determine the most suitable muscle diameter on the basis of the required force. The required force is 2000 N, therefore an MAS-40-... is selected.

**Step 2**  
**Entering load point 1**

Load point 1 is entered into the force/displacement diagram for the MAS-40-...

Force  $F = 2000$  N  
Pressure  $p = 2$  bar

**Step 3**  
**Entering load point 2**

Load point 2 is entered into the force/displacement graph.

Force  $F = 1000$  N  
Pressure  $p = 2$  bar

**Step 4**  
**Reading the length change**

The change in the length of the muscle is read between the load points on the X axis (contraction in %).

Result:  
8.7% contraction.

**Step 5**  
**Calculating the nominal length**

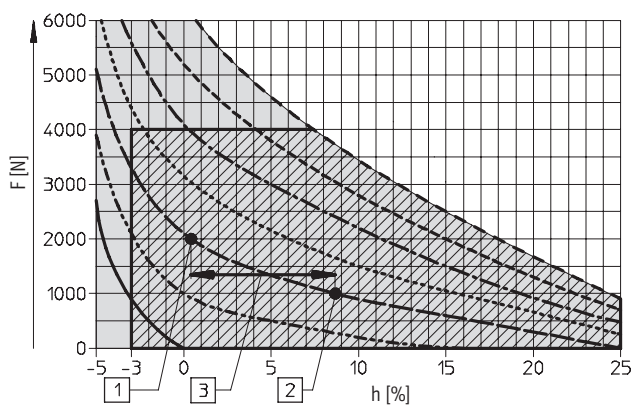
The required nominal muscle length for a stroke of 50 mm is obtained by dividing by the contraction in %.

Result:  
 $50 \text{ mm} / 8.7\% \sim 544 \text{ mm}$ .

**Step 6**  
**Result**

A Fluidic Muscle with a nominal length of 544 mm should be ordered.

For use as a tension spring with a force of 2000 N and a spring travel of 50 mm, a ... is required.



0 bar —————  
1 bar - - - - -  
2 bar - - - - -  
3 bar - - - - -  
4 bar - - - - -  
5 bar - - - - -  
6 bar - - - - -

- 1 Load point 1
- 2 Load point 2
- 3 Length change = 8.7%

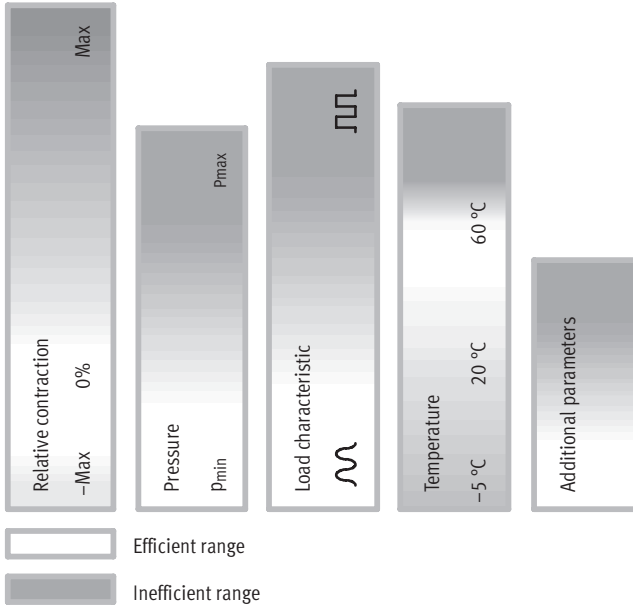
# Fluidic Muscle DMSP/MAS

Sizing

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## Service life (bar height = meaning / influence)

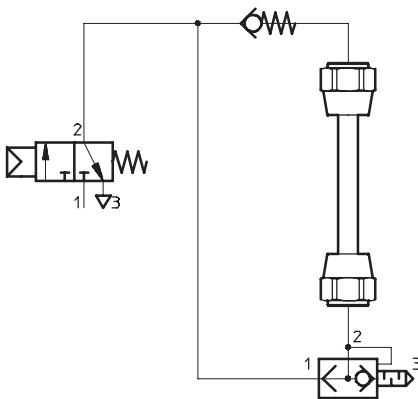
Optimisation through selection of suitable parameters



The service life of the fluidic muscle is between 100000 and 10 million switching cycles for typical applications. Optimisations can be made using the information from the left diagram. The service life thus increases due to a reduction in the

relative contraction (use of a longer muscle). It is also recommended that the pressure be reduced, which is possible because the fluidic muscle is more powerful with lower relative contraction. This measure also improves the service life.

## Reducing the thermal load



The service life of the Fluidic Muscle depends on the contraction, the operating pressure and the temperature. High operating frequencies or high loads can lead to a temperature rise. Targeted pressurisation on one side

and venting on the other side enables the thermal load on the component to be reduced and the service life of the fluidic muscle to be increased (only with fluidic muscle open at both ends).

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