

“The Pressure is always on” – What is a Gas Spring?

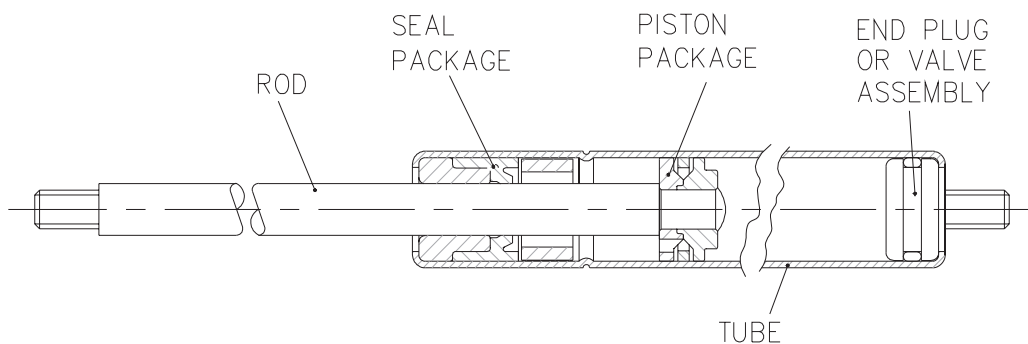
Gas Springs provide direct support for safely lifting, positioning, lowering and counterbalancing weights. They offer the versatility of a wide range of forces, simple mounting, compact size, speed controlled damping and cushioned end motion, combined with a flat force curve.

The weight range supported can be a few kilos up to half a tonne, (from 50 to 5000 Newtons (2 springs)). Gas Springs incorporate proven engineering techniques with thousands of cycles of testing to ensure they meet the standards demanded by customers.

The most popular use is as a support on a horizontally hinged door. However, their versatility and ease of use has been applied to many other applications in industries ranging from transportation and office equipment to off-road vehicles, medical and leisure equipment.

“High Structural Integrity”- Construction

An SFC Gas spring is a sealed energy source containing pressurised inert gas and a small amount of oil. Being **self-contained units** they require no power source or maintenance. With their tough rigid construction, high structural integrity, they provide years of trouble-free operations.



In-depth engineering resources ensure that you receive a quality Gas Spring that has been tested for performance and fitness for purpose. In-house test equipment is available for **mechanical strength tests, thermal tests -40°C to + 100°C), salt spray to ASTM B117, humidity, cycling and actual application tests** to ensure reliability and full product safety. This facility is also available to support customer’s field trials.

WHAT IS A GAS SPRING?

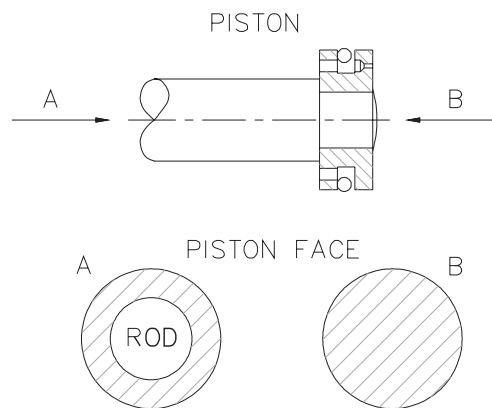
What is a gas spring continued.

“Under Pressure” – How it Works, Simple Operation

SFC Gas springs work by forcing, under pressure, an inert gas (Nitrogen) into a cylinder. The internal pressure then greatly exceeds atmospheric pressure. This differential in pressure exists at any rod position and generates an outward force on the rod, making the Gas Spring extend.

This is due to:

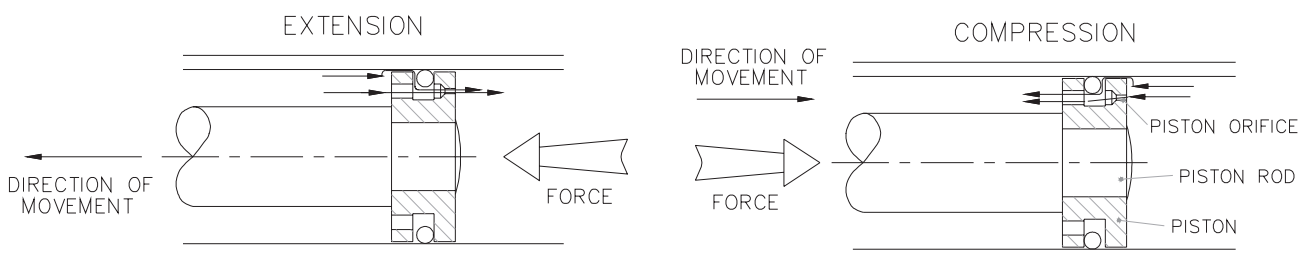
$$\text{Pressure} = \text{Force} \times \text{Area}$$



With the pressure being equal on both sides of the piston, the above means that there is more force acting in direction 'B' than in direction 'A'. This forces the rod out.

When the rod is compressed into the cylinder, the internal pressure and the output force increase according to the volume displaced by the rod. On extension or compression, gas is transferred from one side of the piston to the other via a small orifice. This can be accurately metered to control either the rate of extension, compression or both.

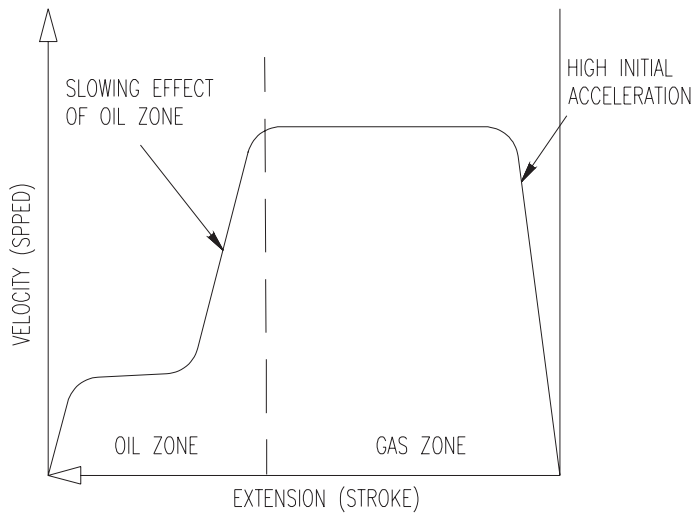
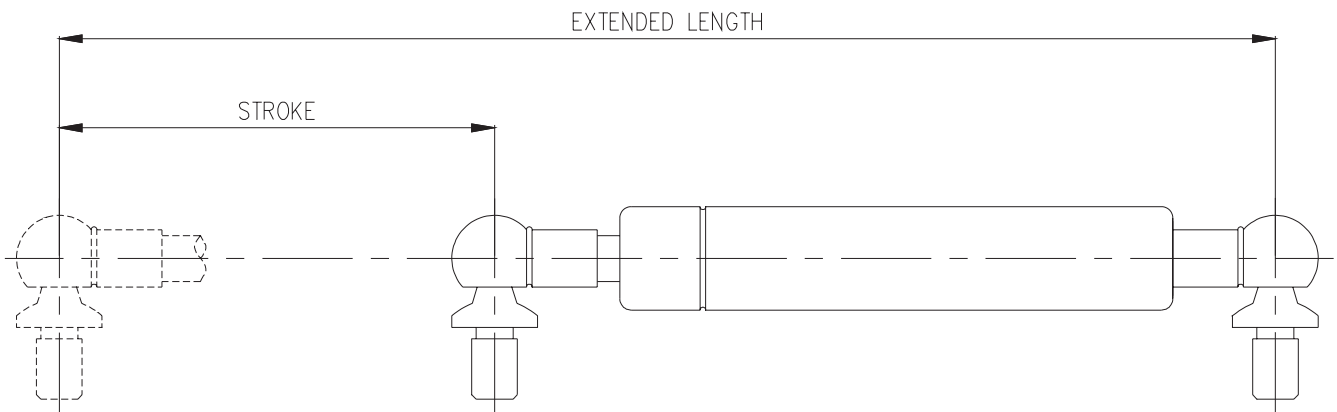
At the end of the extension stroke, oil damping occurs due to a hydraulically cushioned zone. These features help protect hinges and mounts by applying constant force with a damped end of travel.



The flow rate of nitrogen and hydraulic oil is controlled while extending to maintain a controlled extension rate. The flow rate is increased in compression to ease movement.

A gas spring also contains a limited amount of oil that lubricates the seals, piston and piston rod.

When the rod is either compressed or extended, this movement of gas and oil within the cylinder from one side of the piston to the other, creates a damping effect, reducing sudden shocks on mountings and hinges



The rod movement in extension is controlled in the following manner:

Gas flow is directed through a metering orifice in the piston to control the flow of nitrogen giving a constant velocity. During the final part of the extension stroke, the piston passes through the oil zone, decelerating the rate of extension and preventing shock loads being generated.

“Under Pressure” – How it Works, Simple Operation

P1 - Static is quoted as the normal force of SFC gas springs. To measure this force, the gas spring is compressed 10mm then allowed to extend 5mm and held. The static P1 force is measured at that point.

To make up the Dynamic Gas Spring Curve, SFC take measurements at four positions. Following the stroke of a gas spring from extended to compressed and back to extended these dynamic forces are:

On the compression stroke P3 and P4 are measured.

P3 - 5mm into the compression stroke.

P4 - 5mm from full compression.

The force increase between P3 and P4 is due to the volume change as the piston rod enters the cylinder tube.

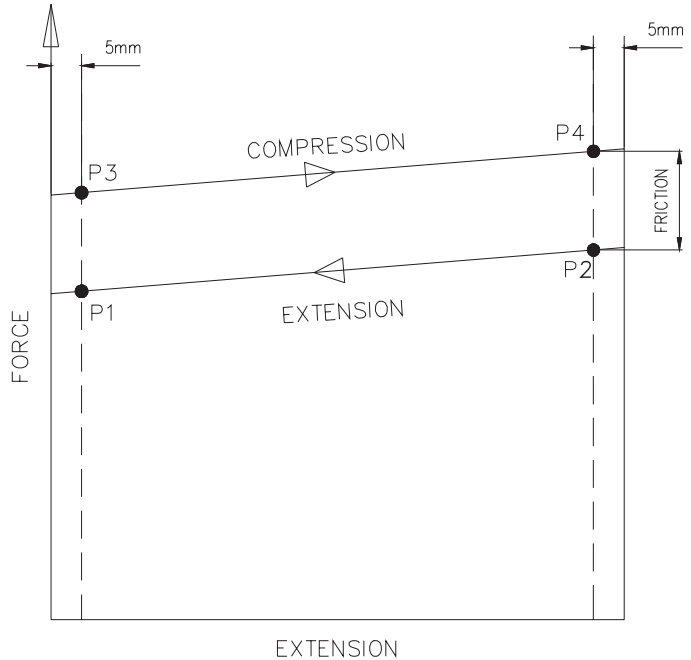
On the extension stroke P2 and P1 are measured.

P2 - 5mm into the extension stroke.

P1 - 5mm from full extension.

The force decrease between P2 and P1 is due to the volume change as the piston rod exits the cylinder tube.

The force difference between the compression force curve, P3 to P4, and the extension force curve, P2 to P1, is due to gas spring friction.



Note: This is a Dynamic Curve. The Gas spring P1 quoted is a Static P1, which is typically more than the Dynamic P1

Handling Forces

In descriptive terms these mean:

System Forces:

P1 This is the force required to keep the lid fully open, e.g. when a car boot lid is fully open.

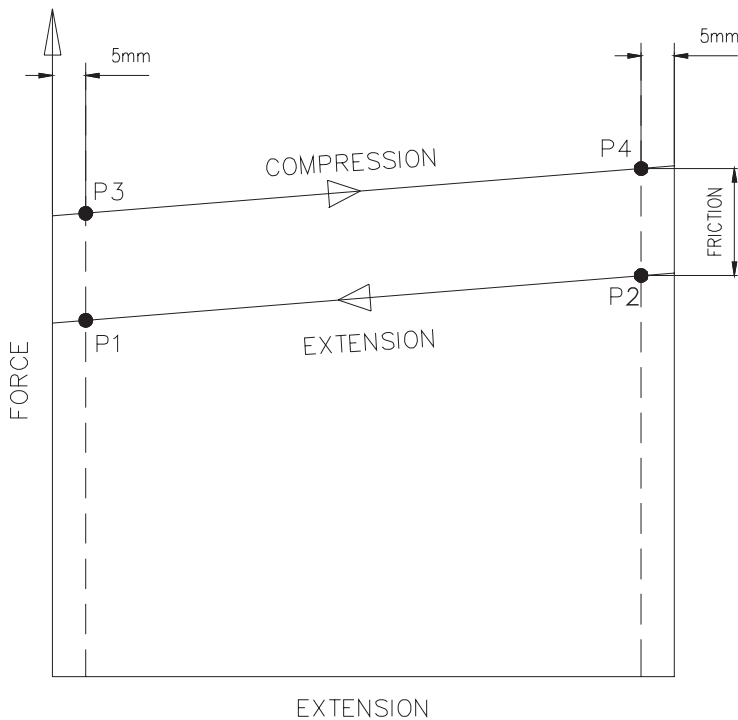
P4 This is the maximum load that the system will see. It is what you would base your hinge and bracket design on.

Ergonomic Forces

P2 This is a key handling force when lifting a lid. It dictates when you have reached an in-balance position.

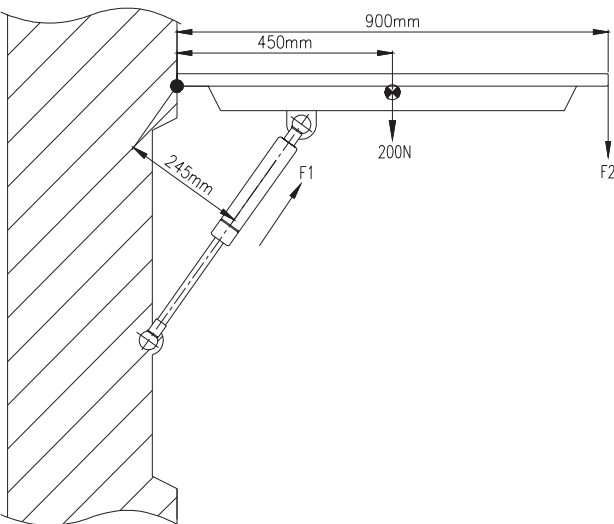
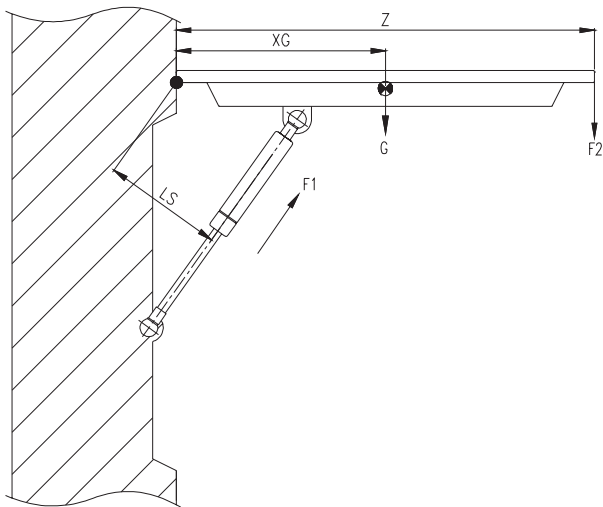
P3 Again a key handling force, this is the force to close when the spring is fully extended.

Generally there is a compromise between the handling forces required to give the correct feel to close the system and the force required to actually lift the weight



Below is a basic calculation which gives an approximation of the minimum required gas spring force for a specified mounting position geometry.

Please remember, we offer an Engineering application solutions service. Through the use of our expert system selection software we can quickly determine the optimum mounting points, the resultant handling forces (both opening and closing forces) and recommend the correct gas spring specification and part number.



$$F1 = \frac{G \times XG}{LS \times A}$$

Estimating Gas Spring Force F1 (N)

- Z = Length of lid from pivot(hinge) point(mm)
- XG = Centre of Gravity(mm). (N.b. take account of Uneven distribution of weight, depending on lid Shape, handles, locks, other components)
- G = Weight of lid in Newtons (kg x 10)
- LS = Radius of Gas Spring Force(mm)
- A = Number of gas springs per application, 2 is usually recommended.

Worked Example for Estimating Gas Spring Force F1 (N)

$$F1 = \frac{200N \times 450mm}{245mm \times 2}$$

$$F1 = 183.67N$$

To estimate the closing effort F2 (N)

$$F2 = \frac{A \times F1 \times LS}{Z}$$

$$F2 = \frac{2 \times 183.67 \times 245}{900} = 100N$$

Notes:

- Gas Springs are charged with nitrogen at very high pressures and under no circumstances should they be opened or subjected to excessive loads.
- Gas Springs must not be exposed to bending forces, tensile forces or side loads. Where possible we recommend the use of ball joints as this will assist in reducing the impact of any misalignment. If you have to use eye connectors remember to support the eye on both sides and allow some float.
- Where possible protect the piston rod from impact damage, scratches, dirt or contamination such as paint or adhesives. Protective plain shrouds are available from SFC, please contact us for further details.

First Determine the type of gas spring you require

Type		Brief Description
Standard Lift Gas Spring	SW	Swift & Sure is the most popular standard lift Gas Spring, available in a range of sizes and end fittings, suitable for a variety of applications. Swift & Sure is an entirely self-contained hydro pneumatic ram with the characteristics of a compression spring, coupled with a small change in force as it extends providing controlled rate of movement.
Locking Safety Shroud Gas Spring	EC	Econoloc Gas Springs eliminate the need for separate safety rods in critical lift assist applications. Incorporating an additional shroud that positively locks when the gas spring is fully extended, the Econoloc protects the operator from potential injury in the event of overload or misuse.
Additional Friction Control	SS	Stop & Stay Gas Springs enable multi-position holding of a counter balanced weight over the entire stroke of the Gas Spring through applying additional friction forces to the gas spring. Easily fitted, its simple lock nut adjustment determines the correct level of support. Once fitted, finger tip control allows movement to any position required of the counterbalanced object.
316L Stainless Steel	SX	Manufactured using 316L Stainless Steel, conferring increased corrosion resistance in industrial, marine and coastal environments. A range of 303 Stainless Steel End Connectors are also available in all styles.
Adjustable Force N.b. (Downwards only)	VL	An adjustable Gas Spring which eliminates the need to calculate the force required on your application. Called Vari-Lift , not only can the gas spring be adjusted to meet your individual requirements. But they can also be adjusted whilst in position, saving, time and effort.
Motion Control Oil Filled Dampers	DM	Dampers are designed to influence the characteristics of movement by providing velocity or time control for applications requiring the controlled arrest of a weight or lid, when moving from one position to another. Motion Control Dampers can be used to enhance performance in a variety of Industrial applications.
End Connectors		SFC offer a wide range of end connectors that will enhance your application. Manufactured from a range of finishes and materials including nylon, steel and zinc and Stainless Steel, they will give many years of trouble-free operation. End fittings can be both the same or you can choose different types and sizes of end connectors for each end. Flexibility is what SFC offers you.
Brackets		SFC has introduced a range of mounting brackets for its industry- leading gas spring range. These brackets are designed to suit the extensive range of SFC end connectors creating a wide range of easy-to-assemble fixing options. (Sizes 6-15 and 8-18 only)
Specials		Please refer to SFC for details of our non-standard products including Dampers, Special Protection Shrouds, 8-19 gas springs.

Gas Spring Sizes	Range of Stroke (Rod) Lengths	Range of Tube Lengths	Force Range	Thread Type
6mm rod dia – 15mm tube dia	60 - 200mm (5mm increments)	90 - 235mm (1mm increments)	50 - 400 N (11 - 90 lbs)	M5 x 0.8
8mm rod dia – 18mm tube dia	60 - 300mm (5mm increments)	105 - 335mm (1mm increments)	100 - 650 N (22 - 146 lbs)	M6 x 1.0
10mm rod dia – 23mm tube dia	60 - 400mm (5mm increments)	105 - 440mm (1mm increments)	150 - 1200 N (34 - 269 lbs)	M8 x 1.25
14mm rod dia – 28mm tube dia	60 - 500mm (5mm increments)	155 - 555mm (1mm increments)	200 - 2500 N (45-562 lbs)	M10 x 1.5



- **Ideal for lifting, supporting & motion control of weights & lids**
- **Standard or Special sizes available**
- **An extensive range of sizes (150mm to 1055mm) & forces (50N to 2500N)**
- **Available in fixed & variable force models**
- **High energy source from a self contained small unit**
- **Also available in 316 Stainless Steel tube & rod**

1. Should a Gas Spring be mounted “Rod up” or “Rod down”?

“Rod down” is the preferred orientation for mounting a Gas spring. An optimum design would permit the support to be oriented rod down through its entire actuation. There are several reasons for this:

In order to achieve the damping or “cushion” at the end of the Gas spring’s stroke, the piston assembly inside of the Gas spring must travel through oil at the end of the stroke. “Rod down” orientation ensures that the oil is in the proper location for full damping to occur.

“Rod down” orientation ensures that the rod and sealing components are lubricated with every stroke of the Gas spring. This reduces seal wear and helps to inhibit corrosion.

2. What types of end connectors can be used when mounting a Gas spring or Damper?

When choosing an end connector, the designer must take into account both tensile and compressive loading to ensure adequate strength and wear. SFC provide a wide range of end connectors including nylon, zinc, steel and stainless steel.

The most common connector involves a ball and socket joint. While this joint style is available in many forms, they all allow rotation about the mounting point, which helps to reduce / minimise side loading on the gas spring or damper. This is important because side loading can reduce the life of the product. Side load may be caused by slight misalignment or twisting in the application.

The design engineer should also be concerned with the clearance around the mounting point. There should be enough room to easily mount and remove the unit from the application.

3. How does temperature affect the life and performance of a Gas spring or Damper?

Temperature affects Gas springs in two ways, output force change and increased susceptibility to gas loss.

As the temperature of the Gas spring changes, the internal pressure changes according to the relationship $P1/T1 = P2/T2$. Therefore, as the temperature increases, so does the internal pressure. As the internal pressure increases, so does the output force. For every 10°C (18°F) change in temperature, the output force changes 3.5 percent.

Very high or very low temperatures can adversely affect the Gas spring's ability to retain its gas charge. At very high temperatures, the permeability of rubber increases and the gas molecules may diffuse through the seal more quickly. Additionally, rubber compounds may begin to soften at elevated temperatures and lose their ability to seal properly. At very low temperatures, rubber compounds may stiffen and also lose their ability to seal properly. SFC's seal design and rubber compound helps to minimize problems at temperature extremes. This allows SFC Gas Springs to perform reliably at temperatures ranging from 40°C (-40°F) to +80°C (176°F).

Within their specified range, Dampers are affected by temperature. The damping effectiveness increases or decreases as the temperature rises and falls. For example, damping increases at lower temperatures.

4. What is the expected life of a Gas spring?

When estimating the life of a Gas spring, one must first determine how much force the support can lose before the application becomes unacceptable. The time it takes to lose this amount of force is considered to be the life of the support.

All Gas springs lose output force over time. The rate at which force loss occurs varies greatly between application and manufacturer. Many factors affect the rate of force loss, such as: size of the support, orientation, amount of cycles, ambient temperature, vibration, and the geometry of the application and time(cycle time). Considering all of the variables, it is very difficult to estimate life accurately without actual testing on the application.

As noted above, all Gas springs will lose output force over time. It is recommended that the gas springs be periodically checked to ensure that they are functioning as intended. This inspection should be implemented as part of a planned maintenance activity, if possible.

5. How can a designer ensure the longest life for a Gas spring in an application?

Orient the support “rod down”. As explained above, this will continually lubricate the seal and rod and reduce permeation through the seal.

Utilize the largest gas volume possible in the support. In general, use the minimum stroke required with the largest body possible. In a support with a large gas volume, small gas losses are imperceptible in the output force. The temperature of the Gas spring should remain well within the temperature limits. If temperature extremes will be encountered, it should be for a short duration and the support should not be cycled while at the extremes. Utilize the highest force Gas spring possible that still provides acceptable handling loads for the application. This will allow for some force loss without the loss of function of the application. Avoid side load, vibration, contamination and damage to the rod.

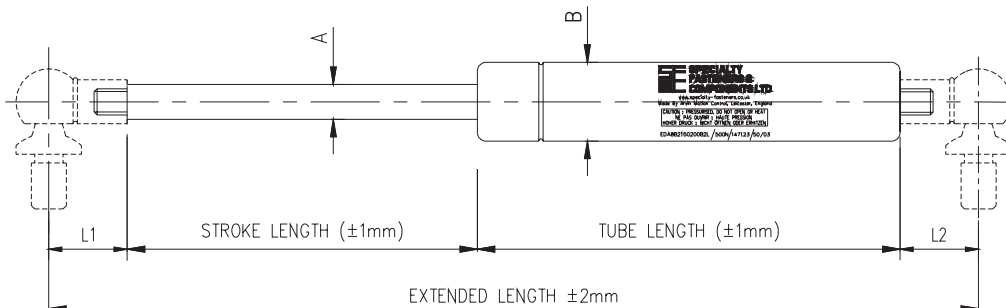
Provide multiple mounting locations so that the support can be moved to accommodate for force loss as the support ages.

Remember: SFC provide a comprehensive engineering application support service. Please use the Gas Spring Application Enquiry Form to send us details of your requirements.

Matching different suppliers gas springs:

If you have an existing gas spring, you will require the following dimensions to help you to select an equivalent SFC gas spring:

- The rod and tube diameters A and B.
- The stroke length (from the shoulder of thread or end connector to the tube).
- The extended length from the centre of the end connectors, or stud end shoulders if no end connectors are used.
- The type of end connectors used.
- The nominal P1 force of the gas spring (see simple guide below).



The first Dimension to take is the Rod / Tube Diameters (A and B), this signifies which size spring you need to look at i.e. size 6-15, 8-18, 10-23, and 14-28.

Then you need to first clarify the extended length of the Gas Spring. (Depending on the application this is important). Secondly, you need to clarify the closed length if possible to check / match to the closest available stroke length.

You then need to make a note of the stroke (Rod) length.

The approximate weight of the lid to be lifted in kg's. (See Table Below). This helps to confirm that they are using an appropriate size gas spring.

From the weight of the lid and using the table below, determine the basic size of Gas Spring	
Gas Spring Size	Approximate Lid Weight
6- 15	Up to 10 kg
8- 18	10 - 40 kg
10- 23	40 - 150 kg
14- 28	150 - 350 kg

Gas spring force:-

Force range is determined by the allowable pressure and the rod buckling load.

Select force in 10 Newton intervals

Gas Spring Size	Force Range In Newton's
6- 15	50 - 400
8- 18	100 - 650
10- 23	150 - 1200
14- 28	200 - 2500

Load Lifted :-

From the weight of the lid and using the table below, determine the basic size of Gas Spring.

Gas Spring Size	Approximate Lid Weight
6- 15	Up to 10Kg
8- 18	10 to 40 Kg
10- 23	40 to 150 Kg
14- 28	150 to 350 Kg

Temperature Limitations

Maximum Temperature capability: all sizes +100 °C. N.B. The actual working temperature of a gas spring will depend on the rod length / tube length and oil level ratio.

Note: All applications with operating temperatures above 20 °C must be checked by SFC for safety.

Minimum Temperature capability: all sizes -40 °C. N.B. The gas springs are tested to survive down to -40 °C. This can involve limited cycling at this temperature. It is advisable that when the gas springs are not in use they are in the compressed position on the application so that the rod is protected within the tube. **Note: All applications with operating temperatures below 0°C must be checked by SFC in the first instance.**

SFC Gas Springs are manufactured at 20 °C. The standard variation in nominal force caused by changes in temperature is 0.3% of a Newton, per +/- °C change from 20°C.

Type	Description	Availability					
		6-15	8-18	10-23	14-28	Fixed Force	Vari-Lift
	Standard Lift gas spring	✓	✓	✓	✓	✓	✓
	Locking shroud safety feature	✗	✓	✓	✓	✓	✓
	Additional friction device gas spring	✓	✓	✓	✗	✓	✓
	Standard gas spring 316L stainless steel	✓	✓	✓	✓	✓	✓
	An Oil Filled spring assembly	✗	✓	✗	✗	✗	✗

Application solutions for:

- **Commercial Vehicles**
- **Car Boot Lids**
- **Machine Guards**
- **Agricultural Equipment**
- **Enclosures**
- **Marine**
- **Caravans**
- **Leisure/Sports**



Benefits

- **Ideal for lifting, supporting & motion control of weights & lids**
- **Standard or Special sizes available**
- **An extensive range of sizes (150mm to 1055mm) & forces (50N to 2500N)**
- **Available in fixed & variable force models**
- **High energy source from a self contained small unit**
- **Also available in 316 Stainless Steel tube & rod**



When Gas Springs are used, it is often found that theoretical forces may be inaccurate because factors such as hinge friction and perceived speed of action and perceived handling will have a bearing on calculations.

Therefore, SFC supply an adjustable force Gas Spring, called Vari-Lift (See Below). Not only can it be adjusted to meet individual preferences, but it can also be adjusted whilst in position, saving you both time and effort.

Benefits

- **No Need to calculate force**
- **Adjustable down to any force within the range**
- **Force can be adjusted after installation**
- **Simple adjustment using standard tool supplied**
- **Ideal for Prototyping and short production runs**
- **Ideal where application weights vary**
- **Available as an option to most types of SFC Gas Springs on request**

These Gas Springs are charged to their maximum force during manufacture. By using the standard tool provided, Gas can be gradually released via the Vari-Lift valve to provide the force suited to your application. Once this has been established, SFC, are then able to measure this force and provide fixed force Gas Springs to your precise requirement.

Vari-Lift Gas Springs can also be used if panel weights vary. These will then allow you to provide the perfect solution to your customer needs every time. Spring weight ranges from 5kg (11lbs) to 250kg (550lbs), force ranges from 50N to 2500N, with standard strokes from 40mm (1.57") to 500mm (19.69").

Vari-Lift versions of the following gas spring ranges are available:

Standard Lift Gas Spring.

Locking Safety Shroud gas springs that lock automatically on full extension.

Additional Friction gas springs that lift and hold in any desired position.

316L Stainless Steel range, the ideal gas springs for high corrosion and clean environments.

Sizes, dimensions and materials are as listed in the following data pages for these ranges. Remember that Vari-Lift versions are supplied fully charged to the maximum force for the particular size gas spring.

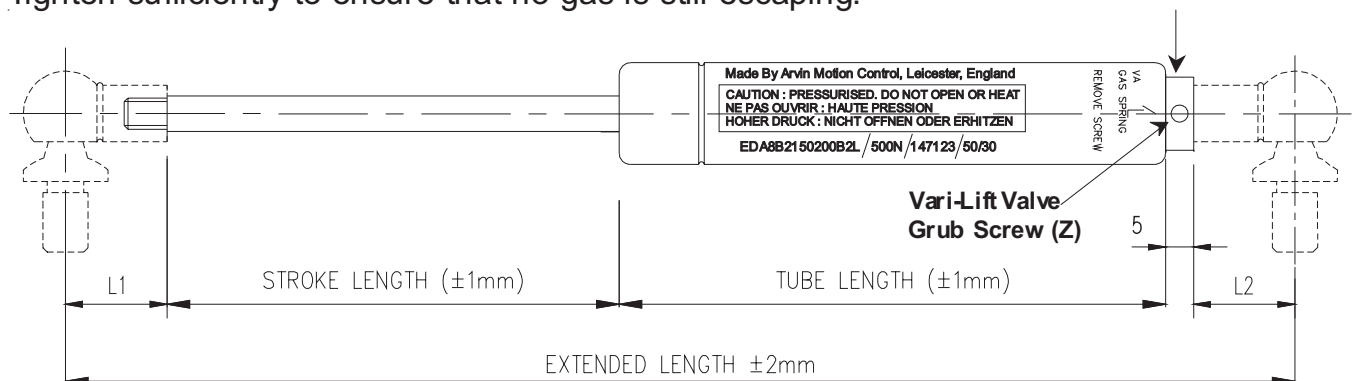


Valve Adjustment Instructions:

Fit the gas spring with the cylinder / tube in the uppermost position. The Vari-lift valve can be seen at the top of the cylinder / tube (X).

Adjustment of the Grub Screw

Ensure the 2mm allen key (provided) is located in the grub screw (Z) to its maximum depth. Undo the screw carefully by rotating anti-clockwise until the gas is heard escaping. When re-tightening care should be taken to ensure that excessive force is not applied, as this will damage the hexagon in the grub screw and make it inoperative. Tighten sufficiently to ensure that no gas is still escaping!



Repeat the process releasing a small amount of gas at a time until the required lifting action is achieved.

WARNING: The force can be adjusted **downwards** only.

It is advisable to add approximately 10% to the weight being supported when adjusting the gas spring. This will reduce the chance of releasing too much gas.

UNDER NO CIRCUMSTANCES SHOULD THE GRUB SCREW BE REMOVED

Note: A slight mist of oil may sometimes be seen escaping when venting gas. This is Normal.



US Patent No. 6273398 & GB Patent No. 2336651