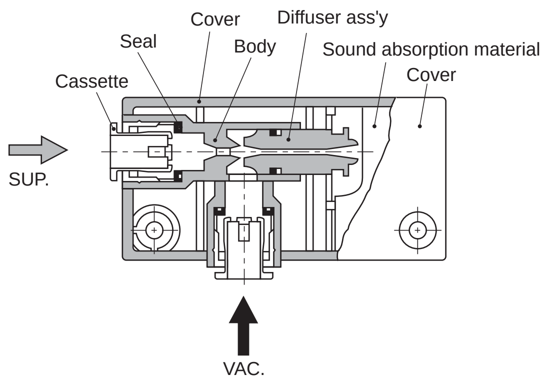
Vacuum generators

Data Sheet

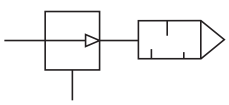
Standard box type generators

A range of light compact boxed vacuum generators with built-in silencers. These units are compact and lightweight for easy mounting to mobile units. The **RS** range includes units with nozzle diameters from 0.5 to 1.3mm.

Construction



Generator symbol



Box type
(Built-in silencer)

Specifications

Fluid ________ Air
Operating pressure range ________ 2.5~6kgf/cm^2
Max. operating pressure ________ 7kgf/cm^2
Operating temperature range ________ 5~60°C
Lubrication ________ Not advised

Max. suction flow rate/air consumption unit

(Nl/min)

Specifications	Max. vacuum pressure mmHg (Torr)	Nozzle diameter mmø 0.5	0.7	1.0	1.3
Max. suction flow rate	660 (100)	5	12	24	40
Air consumption	660 (100)	10	20	34	68

*At 4.5kgf/cm^2

General precautions for all vacuum generators

Air supply side circuit

It is necessary to design appropriate sized piping on air supply side circuit to be in line with the air consumption of each generator. The effective orifice area of tubes, fittings, valves etc. should be large enough to prevent suction flow from pressure drop. Also it is necessary to ensure the air source is sufficient to allow for maximum air consumption of generator and air consumption circuit.

A filter and unlubricated air supply to the generator is recommended for maximum performance.

Vacuum side circuit

Piping between generator and pad etc. should be kept as short as possible to prevent it from unnecessary delay and leakage.

Number of pads

One pad per generator is the general rule. If using two or more pads, they must be seated correctly to avoid leakage.

Selecting nozzle diameter

Selection depends on suction flow rate requirements. Points to consider:

1. Volume of air to be evacuated in Nl/min
2. Porosity of component. If porosity is large a larger nozzle diameter should be selected
3. Air consumption should be considered to maximise efficiency.

Exhaust

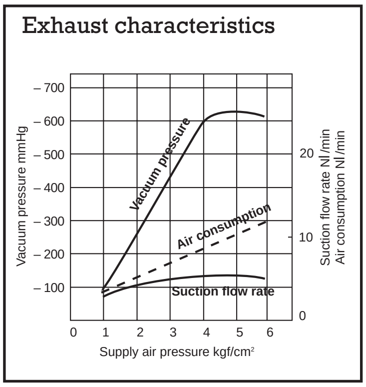
At least one exhaust should be left open.

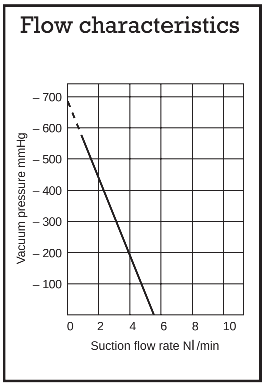
Exhaust characteristics/flow characteristics

Flow characteristics: at 4.5kgf/cm² supply air pressure

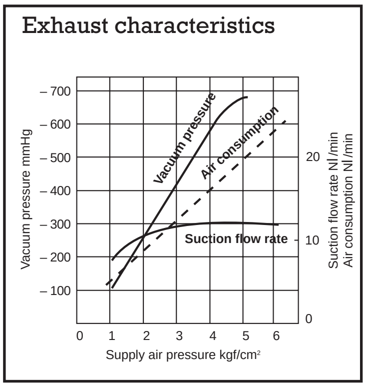
Max. vacuum pressure: –660mmHG (100 Torr)

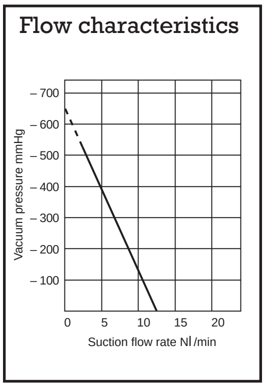
0.5mm nozzle diameter (RS stock no. 725-210)



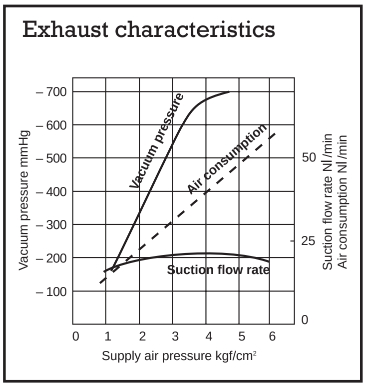


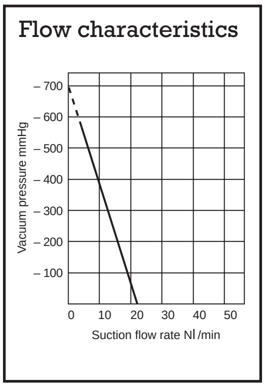
0.7mm nozzle diameter (RS stock no. 725-226)



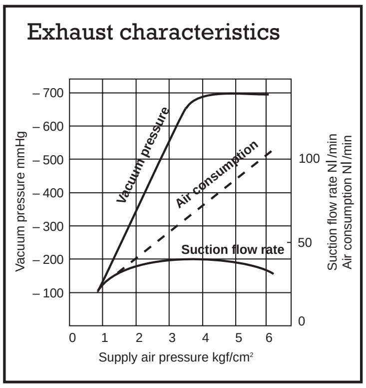


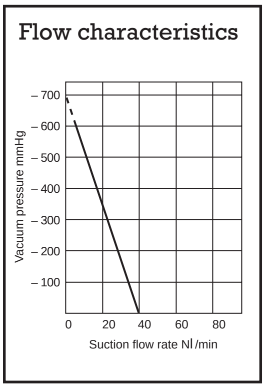
1.0mm nozzle diameter (RS stock no. 725-232)





1.3mm nozzle diameter (RS stock no. 725-248)





One touch fittings/vacuum specifications

Specifications

Operating vacuum pressure ______________10 Torr~

Note 1) Leakage ______________$10^{-5}cm^3$ • atm/sec max.

Ambient and fluid temperature _____________5~60°C

Note 1) Leakage per one fitting when tube is connected.

When connecting tube, the state of connection should exceed minimum bending radius.

Applicable tube

Material	Nylon, Soft nylon, Polyurethane
Note 2) O.D.	ø6, ø8, ø10

Note 2) Accuracy of tube diameter

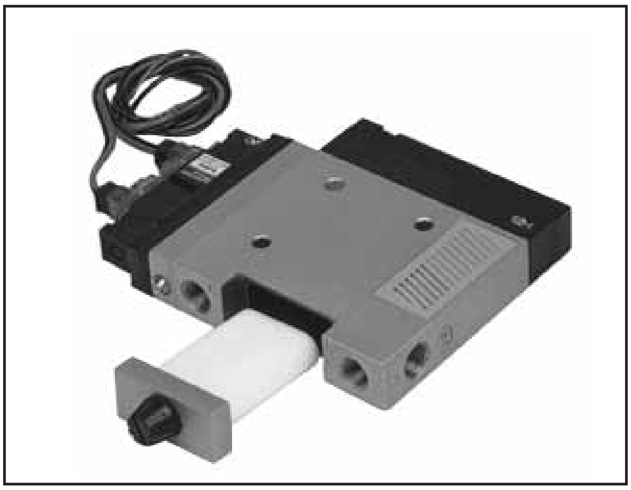
The accuracy of tube diameter should be as follows.
Nylon tube, Soft nylon tube: ±0.1mm
Polyurethane tube: ±0.15/-0.2mm

Precautions

RS tubing can be used with vacuum, and will withstand vacuum pressures in excess of 700mm Hg.

Conventional compressed air fittings should not be used with vacuum. The fittings incorporated with the RS vacuum equipment are suitable for vacuum.

Combination vacuum generator

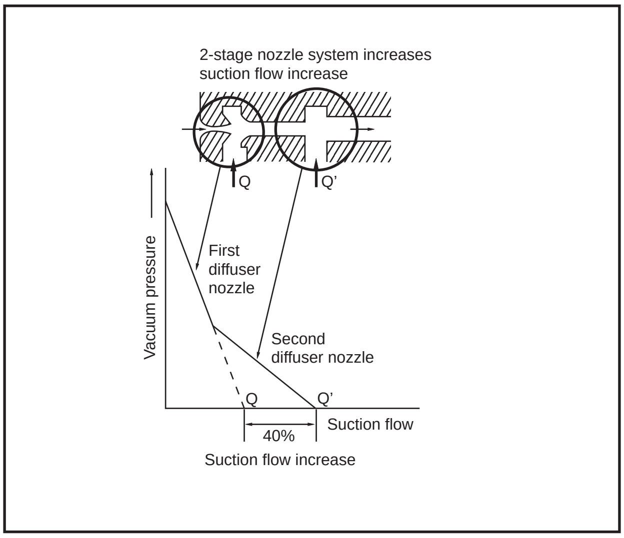


An all in one vacuum generator, silencer, suction filter incorporating an on/off air supply valve. This valve switches the air supply and therefore vacuum on or off via the in-built solenoid. Additionally the unit has a vacuum release (blow-off) valve. This valve switches a positive pressure to quickly release the object being picked. An integral flow control valve provides adjustment to the rate of flow of air used to release the object.

The generator has a nozzle diameter of 1.2mm and incorporates a ⅛ BSP inlet port and two ⅛ BSP outlet vacuum ports. Also included with each unit is a range of fittings for connection to 6mm or 8mm diameter tubing (all 6 fittings are suitable for use with both positive pressure and for use with vacuum). A blanking plug is also included for situations where only one vacuum port is required.

The combination generator incorporates a two stage nozzle system to increase suction flow.

2-stage nozzle system



Specifications

Fluid ______ Air
Max. operating pressure ______ 7kgf/cm^2
Working pressure ______ 2~5.5kgf/cm^2
Operating temperature ______ 5~50°C (with valve)
Operating valve (air supply and release valve) ______ Main (in body) poppet valve
Pilot valve – solenoid valve
Vacuum switch (option) ______ Diaphragm type switch
RS stock no. 725-305
Suction filter ______ 30μm, PE (polyethylene)

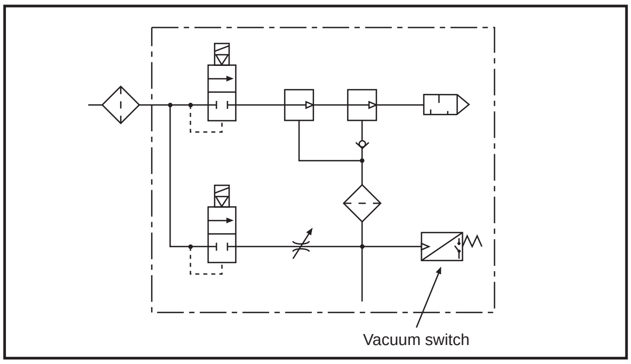
Valve specifications

Operating method ______ Pilot operated
Main valve type ______ Rubber poppet
Effective area (Cv factor) ______ 3mm^2 (0.17)
Operating pressure ______ 2.5~7kgf/cm^2
Rated coil voltage* ______ 24Vdc
Power consumption* ______ 1W
Electrical entry* ______ Plug connector
Max. cycle time ______ 5 times/sec
*Applicable to pilot valves.

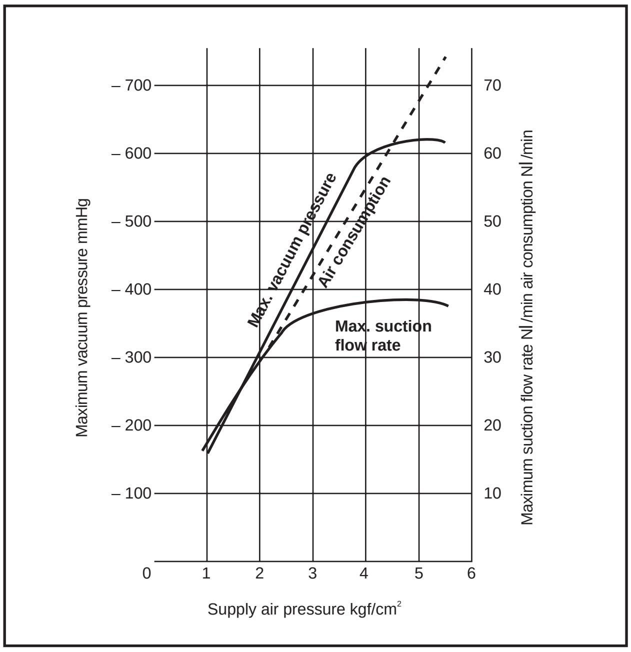
Vacuum switch specifications

Sensor type ______ Diaphragm mechanism
Switch type ______ Contact (reed switch)
Pressure range ______ –200~ –600mm Hg
Differential ______ Max. 150mm Hg
Supply voltage ______ dc12~26V ac24~100V
Indicator light ______ Lighting under ON condition
Max. pressure ______ 5kgf/cm^2
Wire ______ 2 wire

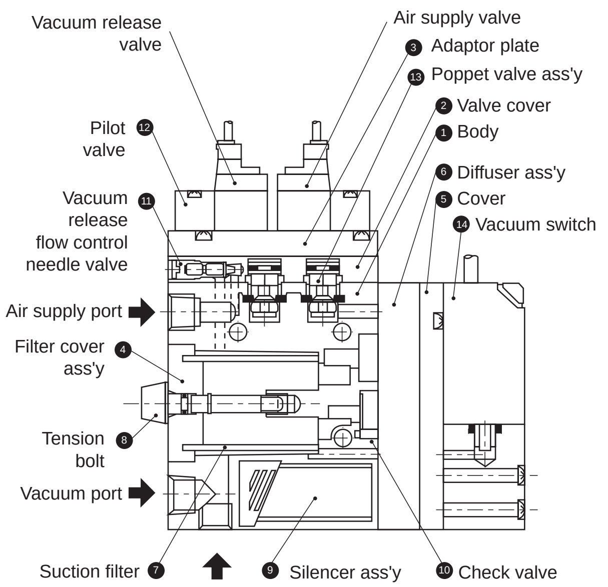
System circuit (including optional vacuum switch)



Generator characteristics – standard supply pressure of 5kgf/cm^2



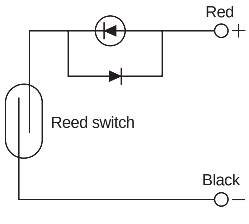
Construction/Parts list



No.	Name	Material
❶	Body	Aluminium diecast
❷	Valve cover	Aluminium diecast
❸	Adaptor plate	Aluminium diecast
❹	Filter cover assembly	–
❺	Cover	Zinc diecast
❻	Diffuser assembly	–
❼	Suction filter	Polyethylene
❽	Tension bolt	Stainless steel
❾	Silencer assembly	–
❿	Check valve	NBR (Nitrile Butyl Rubber)
⓫	Release flow rate control screw	Stainless steel
⓬	Pilot valve	–
⓭	Poppet valve assembly	–
⓮	Vacuum switch	–

Vacuum switch specifications

Reed switch contact: RS stock no. 725-305



Max. switching current : 100mA at 30Vdc
5-20mA at 100Vac

Max power : 2 watts

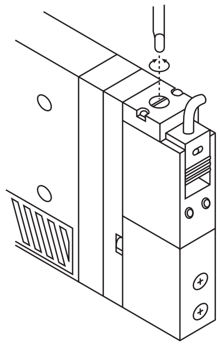
Contact protection

Diaphragm type switches have no built-in contact protection circuit. A suitable protection device should be used when using 5m or more lead wire length, and 100Vac.

See Suppressors/Filter Shielding section of the current **RS** catalogue.

Operating instructions switch adjustment

Diaphragm switch adjustment



There is a slotted adjuster on top of the vacuum switch for setting actuation vacuum pressure levels.

Precautions

How to operate generator with valve

When the pilot valve for air supply is on, air flows to diffuser assembly and vacuum is generated.

When the pilot valve for vacuum break is on, air flows into vacuum port and vacuum is rapidly broken.

Vacuum breaking speed is controlled by the flow control screw.

When the air supply valve is off, air counterflows from silencer by atmospheric pressure and vacuum is broken. However, vacuum break valve should be used to ensure broken vacuum.

Notes

Adjusting the vacuum release

Vacuum release air flow rate is adjusted by vacuum release flow rate control screw.

Cleaning the suction filter

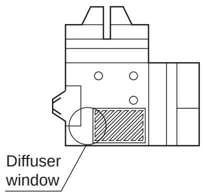
Check filter at regular intervals, if necessary remove and clean with soapy water.

Installing the silencer

Install the internal silencer so that the open vanes are towards the vacuum port side and be sure there are no obstructions blocking the exhaust flow.

To change the orientation of the silencer push the unit out of the generator body, turn it over and push the silencer back into generator body.

Mounting direction of silencer

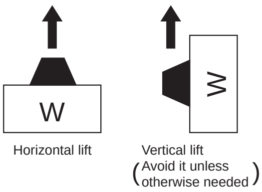


Vacuum pads

How to calculate lift force

By means of equation

W: Lift force (kgf)
P: Vacuum pressure (mmHg)
S: Pad area (cm^2)
t: Safety rate
Horizontal lift: 1⁄2
Vertical lift: 1⁄4



$$W = \frac{P}{760} \times S \times t \times (1.033)$$

Table of theoretical lift force

Theoretical lift force (kgf)

$$= \frac{P}{760} \; S \times t \times (1.033)$$

Pad dia.		ø10
Adsorption area (cm^2)		0.785
Vacuum pressure mmHg	–650	0.694
	–600	0.641
	–550	0.587
	–500	0.534
	–450	0.483
	–400	0.427
	–350	0.374
	–300	0.320

Pad dia.		ø16	ø25	ø40	ø50
Adsorption area (cm^2)		2.01	4.91	12.6	19.6
Vacuum pressure mmHg	–650	1.77	4.34	11.1	17.3
	–600	1.64	4.00	10.2	16.01
	–550	1.50	3.67	9.35	14.7
	–500	1.37	3.34	8.54	13.3
	–450	1. 23	3.00	7.69	12.0
	–400	1.09	2.67	6.83	10.7
	–350	0.96	2.33	6.00	9.34
	–300	0.82	2.00	5.12	8.01

Rubber/Material and characteristics

Item \ Material	Nitrile rubber NBR
Tensile strength	O
Elongation	†
Oil-proof (gasoline)	†
Oil-proof (Benzol)	×
Solvent proof (Toluene)	×
Solvent proof (Alcohol)	†
Weather-proof	O
Ozone-proof	×
Heat-proof	O
Cold-proof	×
Wear-proof	†
Burst-proof	O
Water-proof (Water)	O

† … Little or no influence
O … Good and strong subject to conditions
× … Not compatible

Note. The above table covers only general characteristics of rubber subject to change depending upon the application conditions.

How to calculate response time

Approximate response time upon the time of suction will be worked out by following the equation below.

Calculation of suction flow rate

❶ **Calculation Q1 – Generator/Average suction flow rate**

Q1 = (1⁄2~1⁄3) Q max. Q max: Generator/Maximum flow rate Nl/min.

❷ **Calculation Q2 – Piping system/Maximum flow rate**

Q2 = S × 11.1 S: Effective orifice area of piping mm^2

❸ **Calculation of response time**

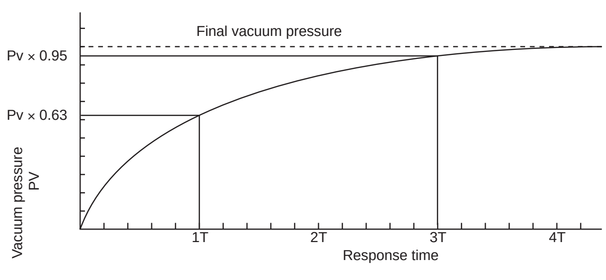
$T1 = \frac{V \times 60}{Q}$ T1= Necessary second to reach final vacuum pressure (PV) × 63%

T2 = 3 × T1 T2: Necessary second to reach final vacuum pressure (PV) × 95%

V: Capacity from generator up to pad *l*

Q: Q1 or Q2 whichever smaller

*Final vacuum pressure (PV): steady pressure after suction.



Calculation/Example

Conditions

(Max. vacuum pressure … 660mmHg
Max. suction rate 24 Nl/min)

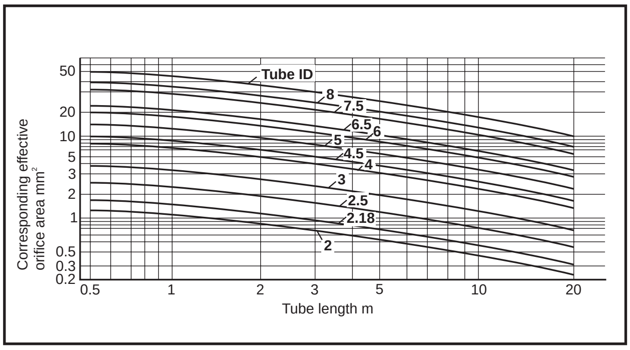
- Tube length … 1m tube dia ø8/ø6
- Pad dia … ø10
- Effective pressure … 63% final vacuum pressure
- Leakage from suction area between work and pad … Nil

❶ Q1 – Generator/Average suction rate

Q1 = (½~⅓) × 24Nl/min = 12-8Nl/min

❷ Piping system/Maximum flow rate

The following diagram shows effective orifice area corresponding to respective tube length.



❸ Capacity from generator up to pad

$$V = \frac{1}{1000} \times \frac{\pi}{4} D^2 \times L$$

V: Capacity*l*

D: Tube I.D. cm

L: Tube length cm

$$= \frac{1}{1000} \times \frac{\pi}{4} (0.6)^2 \times 100 = 0.028l$$

❹ Response time/Calculation

- Compare generator/average suction flow rate Q1 with piping system/max. flow rate Q2.

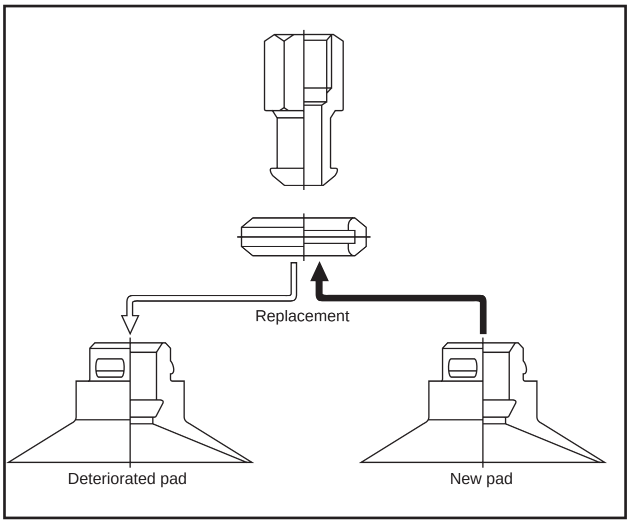
Q1 (8Nl/min) <Q2 (98Nl/min) consequently Q = 8Nl/min

- Response time (at 63% of final vacuum pressure)

$$T1 = \frac{V \times 60}{Q} = 0.21 = 0.2 \text{ sec}$$

Pad maintenance

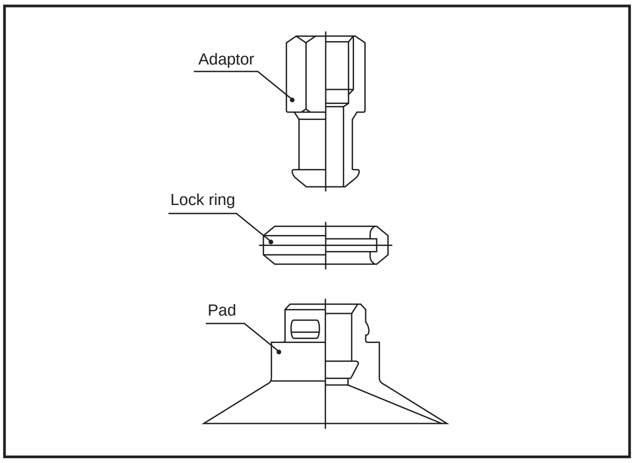
The pad is made of rubber and will deteriorate. The rate of deterioration depends upon the application, environment and temperature. Therefore regular maintenance is necessary. Pads having scratches, cracks, and showing wear should be replaced. Never scratch the surface of the pad.



How to replace

❶ Pull locking ring up until it comes above pad, then pull pad down to remove and replace pad with new one. (Soapy water can assist removal and replacement.)

❷ Confirm that Lock ring is surely locked into pad.



Operation guide

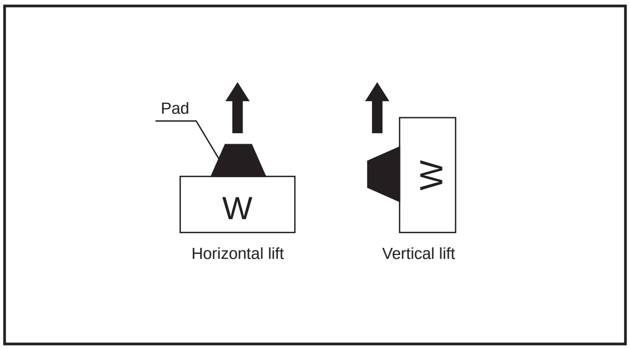
Safety

Vacuum conveyance is, needless to say, to adsorb and convey things to a certain place. The most important thing to be taken into consideration, when designing, is safety. When operating, safety is 'must' and a safety factor should be the first priority when designing.

Mounting

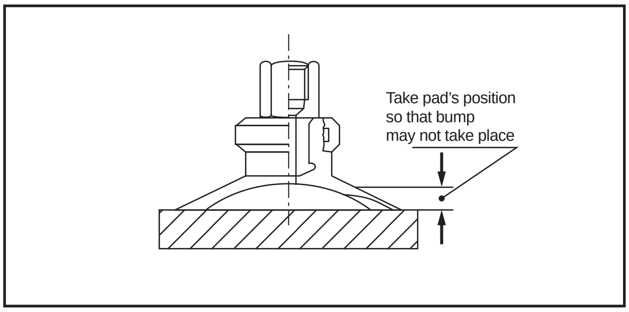
The standard mounting is horizontal. Slant or perpendicular mounting should be avoided as far as possible unless absolutely necessary.

Nevertheless, if unavoidable, it is important to ensure that allowance is large enough to warrant safety.



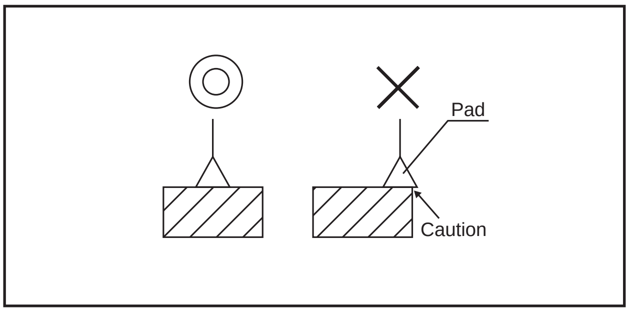
Shock against pad

When pushing the pad against work, prevent shock or excessive power which will lead to deformation, cracking or wear of the pad. It is recommended that this force should fall within the range of deformation of the pad skirt or reduce it to such an extent that the rib area touches only slightly. The use of a buffered pad will help alleviate this if necessary.

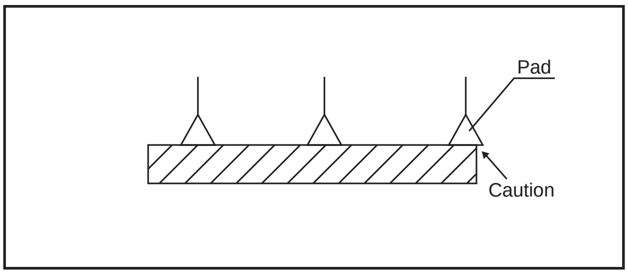


Pad and work/Balance

Care should be taken that the suction area of the pad is smaller than the surface of work. Otherwise vacuum leakage will occur.

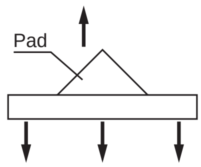
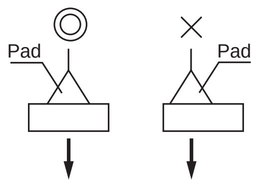
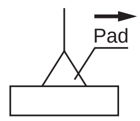


When conveying large surface area plates with multi-pads, the most important thing is the well balanced positioning of pads, and care should be taken to prevent pads from protruding beyond the plate.



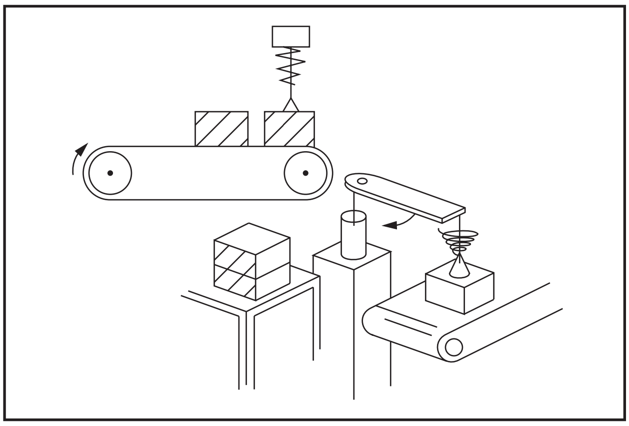
Lifting force, moment, horizontal force

When lifting vertically, not only work weight but also acceleration and wind pressure should be taken into consideration. (Refer to illustration ❶.) Keep the moment of work as small as possible since the pad is not moment-proof. (Refer to illustration ❷.) In the case of horizontal movement with a vertical lifting, pad can receive a large force depending upon acceleration. In general, horizontal holding force comes from friction between pad and work. Therefore, when friction between pad and work are low, acceleration or deceleration of horizontal movement should be kept as low as possible. (Refer to illustration ❸.)

❶	Loading by acceleration and wind pressure lifting 
❷	Pad positioning 
❸	Caution against high acceleration and deceleration 

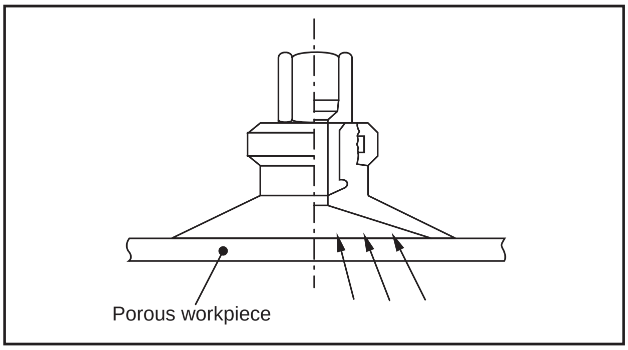
Pad-work/Unsteady distance

When pad and work positioning are difficult as in the case of workpieces with differing heights, it is recommended to use a built-in spring type with buffer in order to create a buffer between pad and work.



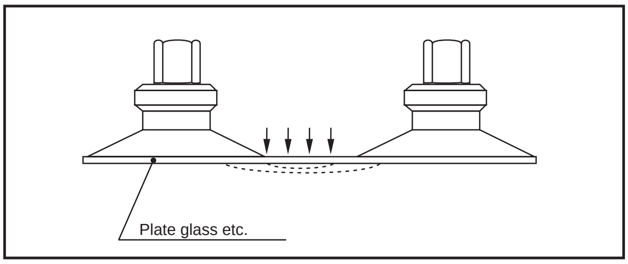
Porous workpiece

In the case of paper or other porous work, select as small a diameter as possible to lift the work. As a lot of air leakage reduces the suction force, a power increase of the generator, selection of larger effective orifice area of piping lines, or other appropriate counter-measures should be taken



Work-flat plate

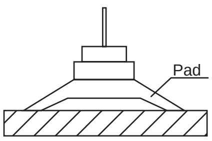
When lifting a large surface area workpiece such as plate glass, a large force due to wind pressure or shock waves can take place. In these cases, appropriate location or size of pad should be selected.



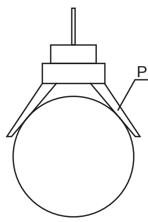
Pad type

Depending upon the shape and material of work, appropriate type of pad should be selected and used.

Flat with rib
For general use and also to be used when work is liable to be deformed

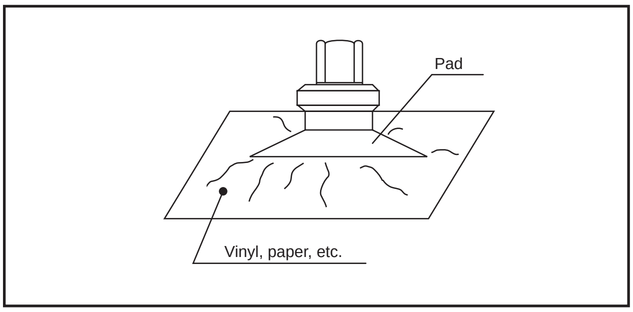


Deep type
To be used when work surface is curved



Soft work

When lifting soft work such as vinyl, paper or thin board, deformation or corrugation of work due to vacuum pressure can occur. In these cases, it is recommendable to use a small pad and to reduce vacuum pressure.



Vacuum circuit/Matching

Generator/No. of pads

The ideal matching situation is one pad for each generator. If multi-pads are used with only one generator and one pad does not make complete suction, then vacuum pressure will be lost.

Subsequently other pads will be unable to complete suction requirement. To remedy this situation each pad should be switched separately and vacuum levels checked with vacuum switches, or put a flow control valve in series with each pad in order that a large leakage does not occur, even if one pad is mispositioned. When using a multi-pad with a multi-generator system, it is important to consider, when designing, the disposition of pads and the piping circuitry in order to ensure adequate safety. Even if one generator fails to operate then the remaining pads must secure the work.

Piping resistance

The piping system should be compatible with the capacity and suction force of the generator. Excessively large piping and oversize pads lead to a long response time.

The important point when piping is to make piping volume small, to minimise flow resistance from fittings, tube and pad fittings, and to reduce leakage to a minimum.

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