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.

Specifications
Fluid ________________________________ Air
Operating pressure range _____________ 2.5~6kgf/cm²
Max. operating pressure _______________ 7kgf/cm²
Operating temperature range ____________ 5~60°C
Lubrication ___________________________ Not advised

Max. suction flow rate/air consumption unit
(Nl/min)

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Max. vacuum pressure mmHg (Torr)</th>
<th>Nozzle diameter mms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. suction flow rate</td>
<td>660 (100)</td>
<td>5 12 24 40</td>
</tr>
<tr>
<td>Air consumption</td>
<td>660 (100)</td>
<td>10 20 34 68</td>
</tr>
</tbody>
</table>

*At 4.5kgf/cm²

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 ______________ 10⁻⁵cm³ • 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

<table>
<thead>
<tr>
<th>Material</th>
<th>Nylon, Soft nylon, Polyurethane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note 2) O.D.</td>
<td>φ6, φ8, φ10</td>
</tr>
</tbody>
</table>

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 ½ BSP inlet port and two ½ 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**: 7 kgf/cm²
- **Working pressure**: 2~5.5 kgf/cm²
- **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
- **Suction filter**: 30µm, PE (polyethylene)

### Valve specifications

- **Operating method**: Pilot operated
- **Main valve type**: Rubber poppet
- **Effective area (Cv factor)**: 3 mm² (0.17)
- **Operating pressure**: 2.5~7 kgf/cm²
- **Rated coil voltage**: 24 Vdc
- **Power consumption**: 1 W
- **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~ -600 mm Hg
- **Differential**: Max. 150 mm Hg
- **Supply voltage**: dc12~26V, ac24~100V
- **Indicator light**: Lighting under ON condition
- **Max. pressure**: 5 kgf/cm²
- **Wire**: 2 wire

System circuit (including optional vacuum switch)

Generator characteristics – standard supply pressure of 5 kgf/cm²
Construction/Parts list

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>❶</td>
<td>Body</td>
<td>Aluminium diecast</td>
</tr>
<tr>
<td>❷</td>
<td>Valve cover</td>
<td>Aluminium diecast</td>
</tr>
<tr>
<td>❸</td>
<td>Adaptor plate</td>
<td>Aluminium diecast</td>
</tr>
<tr>
<td>❹</td>
<td>Filter cover assembly</td>
<td>-</td>
</tr>
<tr>
<td>❺</td>
<td>Cover</td>
<td>Zinc diecast</td>
</tr>
<tr>
<td>❻</td>
<td>Diffuser assembly</td>
<td>-</td>
</tr>
<tr>
<td>❼</td>
<td>Suction filter</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>❽</td>
<td>Tension bolt</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>❾</td>
<td>Silencer assembly</td>
<td>-</td>
</tr>
<tr>
<td>❿</td>
<td>Check valve</td>
<td>NBR (Nitrile Butyl Rubber)</td>
</tr>
<tr>
<td>11</td>
<td>Release flow rate control screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>12</td>
<td>Pilot valve</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Poppet valve assembly</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Vacuum switch</td>
<td>-</td>
</tr>
</tbody>
</table>

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

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.
Vacuum pads

How to calculate lift force

By means of equation

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

Table of theoretical lift force

Theoretical lift force (kgf)

\[ = \frac{P}{760} S \times t \times (1.033) \]

<table>
<thead>
<tr>
<th>Pad dia.</th>
<th>( \varnothing 10 )</th>
<th>( \varnothing 16 )</th>
<th>( \varnothing 25 )</th>
<th>( \varnothing 40 )</th>
<th>( \varnothing 60 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adsorption area (cm²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-650</td>
<td>0.694</td>
<td>2.01</td>
<td>4.91</td>
<td>12.6</td>
<td>19.6</td>
</tr>
<tr>
<td>-600</td>
<td>0.641</td>
<td>1.77</td>
<td>4.34</td>
<td>11.1</td>
<td>17.3</td>
</tr>
<tr>
<td>-550</td>
<td>0.587</td>
<td>1.64</td>
<td>4.00</td>
<td>10.2</td>
<td>16.01</td>
</tr>
<tr>
<td>-500</td>
<td>0.534</td>
<td>1.50</td>
<td>3.67</td>
<td>9.35</td>
<td>14.7</td>
</tr>
<tr>
<td>-450</td>
<td>0.483</td>
<td>1.37</td>
<td>3.34</td>
<td>8.54</td>
<td>13.3</td>
</tr>
<tr>
<td>-400</td>
<td>0.427</td>
<td>1.23</td>
<td>3.00</td>
<td>7.69</td>
<td>12.0</td>
</tr>
<tr>
<td>-350</td>
<td>0.374</td>
<td>1.09</td>
<td>2.67</td>
<td>6.83</td>
<td>10.7</td>
</tr>
<tr>
<td>-300</td>
<td>0.320</td>
<td>0.96</td>
<td>2.33</td>
<td>6.00</td>
<td>9.34</td>
</tr>
</tbody>
</table>

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

1. Calculation Q1 – Generator/Average suction flow rate

\[ Q_1 = \frac{Q_{\text{max}}}{2} \]

Q max: Generator/Maximum flow rate Nl/min.

2. Calculation Q2 – Piping system/Maximum flow rate

\[ Q_2 = S \times 11.1 S \times 11.1 \]

S: Effective orifice area of piping mm²

3. Calculation of response time

\[ T_1 = \frac{V \times 60}{Q} \]

T1: Necessary second to reach final vacuum pressure (PV) \times 63%

\[ T_2 = 3 \times T_1 \]

T2: Necessary second to reach final vacuum pressure (PV) \times 95%

V: Capacity from generator up to pad

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

Q1 – Generator/Average suction rate
Q1 = (1/2~1/3) × 24Nl/min = 12-8Nl/min

Piping system/Maximum flow rate
The following diagram shows effective orifice area corresponding to respective tube length.

Capacity from generator up to pad

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

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

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)
  \[ T1 = \frac{V}{Q} \times 60 = 0.21 = 0.2 \text{ sec} \]

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
- 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.)
- 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 multipads, 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.)

Loading by acceleration and wind pressure lifting

Pad positioning

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.

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 recommended 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.