Automatic Balancing with Cylinder Load Changes

Balance Controller
VY511, VYU5

Three Operating Functions to Achieve Energy Saving Automation

- **Manual Operation**: Auto balance only
  - Human support
- **Internally Set Operation**: Auto balance + Drive
  - Lifter
  - Parts assembly
- **External Input Operation**: Auto balance + Drive
  - Holding force control
  - Tension control
  - Robotic support
The balance pressure is automatically set

Easily installed without space constraints
The balance function can be easily provided to a production line or in equipment by providing only air pressure piping.

Three operations to accommodate a wide range of applications

1. Manual operation (Auto balance only)

After the balance pressure has been set, the cylinder is moved by an external force. (Set the rotary switch to 0 or 1. Refer to the instruction manual for details on the rotary switch settings.)

For assisting human operators (Manual operation)

By inputting the start signal, an air pressure that offsets the weight of the workpiece is automatically set.

System Composition

Explanation of the air circuit diagram

Electro-pneumatic HYREG (VY1200-00-N)
The secondary pressure is set in accordance with the analog voltage of 1 to 5V that is input from the controller.

3 position valve (VEX3222-5M)
When the start signal is input to the controller, it switches automatically to SOL.b and through the throttle valve prevents the cylinder from quick extensions. When the setting is completed, it switches automatically to SOL.a. Also, during an emergency stop or a power outage, no current will be applied to the valve, and the pressure in the cylinder will be sealed.

Manual valve (Built-in base)
When an emergency stop is input or a power outage lasting longer than 5 minutes occurs, the set data will be erased. To reset the data, the cylinder’s piston must be within the operating range of the auto switch that is installed in the origin position. If the power is supplied to the controller after an emergency stop or a power outage lasting longer than 5 minutes, SOL.a, SOL.b (air sealed condition), and the electro-pneumatic HYREG are turned OFF and cannot operate the cylinder. Therefore, a valve that has been provided for manually operating the cylinder is used to operate the cylinder via the throttle valve.

MR: Press this button to discharge the air from the cylinder.
MP: Press this button to supply air to the cylinder.

Throttle valve (variable throttle)
This valve is used for preventing the cylinder from shooting out when the balance pressure is being set. For safety, this valve is fully closed at the time of shipment.

Throttle valve (fixed throttle)

Air circuit

Controller VYUSC-3D

Valve VY511-020

Air cylinder

Accommodates your specs

External equipment; e.g. PLC

Electrical circuit

Air circuit
2. Internally set operation (Auto balance + Drive)
After the balance pressure has been set, ON/OFF signals are sent to the terminal block to change the cylinder’s balance pressure. Thus, driving the cylinder. A trimmer inside the controller is used to adjust the settings for changing the balance pressure. (Set the rotary switch to 2 or 3.)

Lifter (Internally set operation)
By inputting the operation signal after the auto balance, the balance pressure will be broken and the workpiece will be loaded in accordance with the value that is set in the controller.

Parts assembly (Internally set operation)
After both systems A and B have been auto balanced, an operation command is input to the controller to operate the cylinder. At the point at which the auto switch for stopping has been tripped, systems A and B are stopped to assemble parts.

3. External input operation (Auto balance + Drive)
After the balance pressure has been set, the balance pressure is changed in accordance with the voltage (0 to 10V) that is input to the terminal block in order to drive the cylinder. (Set the rotary switch to 4 or 5.)

Holding force control (External input operation)
The gripping force can be changed in accordance with the external input voltage, such as when the workpiece material is changed.

Tension control (External input operation)
After the auto balance, the tension can be remotely controlled as desired in accordance with the external input voltage.

Robot support (External input operation)
After the auto balance, by inputting the torque monitor that has been output from the motor driver into the controller, the cylinder’s balance pressure can be changed. As a result, the torque that is applied to the motor is automatically reduced.
**Series VY511/VYU5**

### How to Order

**Valve**

**VY511 — 020**

**Exclusive controller**

**VYU5**

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**Specifications**

<table>
<thead>
<tr>
<th>Valve</th>
<th>Exclusive controller</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>VY511-020</td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td>VYU5-D</td>
</tr>
<tr>
<td><strong>Driving power</strong></td>
<td>24V DC±15%, 0.4A</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>NPN open collector output</td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>P</td>
</tr>
<tr>
<td><strong>Input signal</strong></td>
<td>NPN open collector (24V DC 50mA)</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>P</td>
</tr>
<tr>
<td><strong>Output signal</strong></td>
<td>P</td>
</tr>
<tr>
<td><strong>Valve output</strong></td>
<td>Valve output: 24V DC, 1.8W, 2 pieces</td>
</tr>
<tr>
<td><strong>Temp range</strong></td>
<td>0 to 50°C No condensation</td>
</tr>
<tr>
<td><strong>Humidity range</strong></td>
<td>35 to 85% No condensation</td>
</tr>
<tr>
<td><strong>Insulation resistance</strong></td>
<td>1000V AC in one minute, 20mA or less (Between 0V terminal of 24V DC and mounting part for resin bowl fixation)</td>
</tr>
<tr>
<td><strong>Noise resistance</strong></td>
<td>500V DC, 50MΩ or more (Between 0V terminal of 24V DC and mounting part for resin bowl fixation)</td>
</tr>
<tr>
<td><strong>Vibration resistance</strong></td>
<td>2G or less</td>
</tr>
<tr>
<td><strong>Shock resistance</strong></td>
<td>10G or less</td>
</tr>
<tr>
<td><strong>Current consumption</strong></td>
<td>0.4A or less</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>200g</td>
</tr>
</tbody>
</table>

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**Note:** Valve should be used with exclusive controller.
Selection of Cylinder Size

1. Select the cylinder size according to the load that is applied to the cylinder. (Refer to graph A)

2. Is the load weight range of the selected cylinder greater than the minimum load weight? (Refer to graph A)
   - Yes
     - Can a back pressure be applied to the cylinder? (Approximately 0.2MPa)
     - Yes
       - Is the load weight range of the selected cylinder within the load ratio of 90%? (Refer to graph A)
       - Yes
         - Is the cylinder speed appropriate? (Refer to graph B)
         - Yes
         - Use graph C as a guide for the balance completion time.
         - No
     - No
6. No

If the cylinder’s load is smaller than the theoretical thrust that is generated when 0.5MPa is applied to the cylinder to be used, the balance operation cannot be performed.

Graph A: Load weight range

Graph B: Max. driving speed at manual operation

Graph C: The balance completion time

- Conditions
  - Supply air pressure: 0.7MPa
  - Mounting position: Vertically facing downward
  - Supply port: Front port
  - Work mounting position: Fixed to the piston rod (Without the guide)
  - Cylinder: CDG1G (20 to 100) -200- K59S
  - After preparatory operation

- System
  - Silencer: AN200
  - Tube size (Nylon tube): T1075 (ø10)
  - Fittings (4 pcs.): DL10-02
  - Conditions
    - Supply air pressure: 0.5MPa
    - Load ratio: 50%
    - 90° elbow: 1 pcs.
    - When load ratio is 0% (no load), maximum driving speed is 1.2 times and when 75%, it is 0.7 times of these figures.
Series VY511/VYU5

## Precautions

Be sure to read before handling. Refer to p.6-26 and 6-27 for Safety Instruction and common precautions on the products mentioned in this catalog.

### Operation and Adjustment

#### Before Handling

**Caution**

Operating air quality
1. Air of poor quality could cause an equipment malfunction. Use compressor oil with a minimal generation of oxidants and make sure to install a dust separator (SMC’s AM series). Refer to the No.4 system of the Compressed Air Cleaning Systems.

2. Air source
   - When the balance pressure and the source pressure become equal, fluctuations in the source pressure cause the cylinder’s balance pressure to fluctuate, which may cause the cylinder to operate. Therefore, install an air filter on the source pressure side or increase the size of the cylinder that is used.

3. Built-in throttle valve
   - The throttle valve that is built into the solenoid valve is fully closed at the time of shipment to ensure safety. The cylinder will not operate if the solenoid valve is used in the state in which it was shipped. Therefore, use the throttle valve by opening it gradually to adjust the cylinder speed.

#### Operation

**Warning**

1. Back-up of the balance pressure data
   - The balance pressure data is backed up by the controller for approximately 5 minutes during a power outage or when the power supply has been turned off. If the power to the controller is interrupted longer than 5 minutes, the balance pressure data could be erased. Therefore, if the power to the controller has been interrupted longer than 5 minutes, operate the controller while observing the setting completion signal that is output by the controller (terminal block names: SET UP1, SET UP2).

2. Yes/No switching for workpieces (terminal block name: SEL)
   - Because “SEL” can be switched as desired regardless of whether the home position switch is ON or OFF, be aware of jumping up or dropping off of the cylinder during switching.

**Caution**

1. Setting of the balance pressure after a long stopped period
   - The friction resistance of the cylinder’s sliding surface increases when the cylinder remains stopped for a long period of time. When the balance pressure is set up under this condition, a proper balance pressure might not be obtained. Therefore, perform a warm up operation of the cylinder.

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#### Cylinder Selection

**Caution**

1. Minimum load weight for transporting
   - Use a cylinder with a minimum load weight that is greater than the theoretical thrust that is generated when 0.2MPa is applied to the cylinder to be used. If a cylinder with a load weight that is smaller than the theoretical thrust is used, the balance pressure cannot be set.

2. Cylinder installation
   - As a rule, trunnion or clevis brackets cannot be used to rock the cylinder while setting the balance pressure because the load that is applied to the cylinder cannot be maintained at a constant level.

3. Minimum sensing weight after balancing
   - Minimum sensing weight = Cylinder friction + Valve error + Exterior guide friction + Cylinder friction + Cylinder minimum operating pressure x piston area
   - Valve error = VY 1200 sensitivity (≈ 0.01MPa) x piston area
   - Refer to the data of the respective guide for the friction of the exterior guide.
   - For example, when a cylinder of the CA1100 series is used, install it vertically, and without a guide.

   **(Unit: N)**

<table>
<thead>
<tr>
<th>Bore size (mm)</th>
<th>Min. sensing weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø40</td>
<td>26</td>
</tr>
<tr>
<td>ø50</td>
<td>40</td>
</tr>
<tr>
<td>ø63</td>
<td>62</td>
</tr>
<tr>
<td>ø80</td>
<td>100</td>
</tr>
<tr>
<td>ø100</td>
<td>160</td>
</tr>
</tbody>
</table>

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#### Setting

**Caution**

1. Cylinder speed while setting the balance pressure
   - The cylinder could shoot out when setting the balance pressure. Therefore, before setting the balance pressure, lower the cylinder speed by adjusting the variable throttle that is built into the solenoid valve. Also, make sure that SOL.a and SOL.b are wired correctly, because if the wires are reversed, the variable throttle cannot be adjusted during the balance pressure setting.

2. Cylinder cushion
   - When using a cylinder that is equipped with a cushion, it might not be possible to set the balance pressure if the cushion is excessively restricted. Therefore, use the cylinder with its cushion open.

3. Load fluctuations while setting the balance pressure
   - Due to the processes of centering the equipment, synchronizing it with other actuators, or pulling the piping during setting. In such a case, it might not be possible to accomplish an optimal balance pressure setting. Therefore, while setting the balance pressure, make sure to operate the cylinder in such a way that the load does not fluctuate.

4. Inputting of the emergency stop signal (terminal block name: STOP)
   - The emergency stop signal can be received in the 0V and open state. To operate the balance controller, always operate in the 0V and short state.

5. Setting of the auto switch
   - The cylinder’s pressure increase and pressure decrease are detected by the ON/OFF operation of the auto switch. Therefore, install the auto switch at the home position of the cylinder as much as possible. If the auto switch is not at the home position, a setting error will result, making it difficult to accomplish an optimal balance. (Use an auto switch rated 24V DC, with a minimum amperage capacity of 10mA.)
Valves

3 position valve (VEX3222-5M)

Caution

1. Energizing time
   When the valve is energized continuously for a long period of time, make sure to not exceed 1,400 hours (equivalent to approximately 2 months) per year with the condition that the valve is switched at least once every 30 days.

2. Installation and removal of the socket with lead wires
   - To install the socket with lead wires:
     Insert the socket into the square holes (marked + and –) of the connector. Then, grasp the lead wires and push them all the way in and engage the hook of the socket with the seat of the connector to lock it in place. When the lead wire is pushed in, the hook opens and locks automatically. Then, lightly pull on the lead wires to make sure that they are locked.
   - To pull out the socket with lead wires from the connector:
     Pull out the lead wire while using a thin rod (< 1mm) to push the hook of the socket. To reuse the socket, open the hook outwards.

Installation and removal of the connector

- To install the connector:
  Place the connector directly over the pin while pinching the lever and the connector body with your fingers. Then, push the tab of the lever into the groove of the cover to lock it in place.

- To pull out the connector:
  Push the lever down with your thumb, and pull the connector straight out while removing the tab from the groove.

Electro-pneumatic HYREG (VY1200-00-N)

Caution

1. Pressure gauge
   If equipped with a pressure gauge, be aware of the possibility of the gauge being affected due to sudden pressure fluctuations.

2. How to use DIN connector
   - DIN connector wiring procedure
     1. Loosen the retaining screw and pull the connector from the solenoid valve terminal block.
     2. Remove the retaining screw, insert the tip of a flat head screw driver into the groove below the terminal block and pry it up to separate the terminal block from the housing.
     3. Loosen the terminal screws (slot head screws) on the terminal block. Then, in accordance with the wiring procedure, insert the cores of the lead wires into the terminals and tighten the terminal screws to secure the wires in place.
     4. Tighten the ground nut to secure the cord.

Pressure gauge

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DIN connector outlet changing procedure

After the terminal block has been separated from its housing, reassemble the housing in the desired direction (in four 90° increments) to change the cord outlet. Make sure to push or pull the connector straight, without tilting it diagonally.

Applicable wire and connector part number

- Cord external diameter: ø4 to ø6.5
  c.f. 3-core, 0.5mm² (equivalent to JISCC3306)
- Connector part number: VK300-82-1

M type

Connector

Socket

DIN17071-1

Grommet

Washer

Ground nut

Socket
terminal block

Terminal screw

(Light mounting location)

Slit area

(Voltage symbol)

Terminal block

Housing

Connector

Pin

Lever

DC indicator

Cover

DC coil (+: Red, –: Black)

Lead wire:
0.2 to 0.33mm²
(Max. cover diameter: ø1.7mm)

1.15-35
Drop prevention countermeasure

**Caution**

As a countermeasure against dropping in case the source pressure is down or the valve cannot be switched because it is clogged with debris, it is recommended to install a pressure switch or a limit switch as a safety measure. Furthermore, the safety performance can be improved by using a cylinder with a built-in brake mechanism. Although an example is shown in the diagram below, there are times in which a countermeasure against dropping cannot be accomplished due to the length of the piping or the response speed of the sequence controller. Therefore, be aware that it might be necessary to conduct a test on the actual equipment.

(System Example) A system that effects an emergency stop of the controller and applies the brake on the cylinder if the valve’s secondary pressure surveillance pressure switch has been turned ON after the setting has been completed.

(System Example) A system that effects an emergency stop of the controller and applies the brake on the cylinder if the auto switch for the limiter is turned ON after the setting has been completed.
Countermeasure for preventing the cylinder from running after the load has been removed

⚠️ Caution

After completing the balance and performing an operation that involves the loading of a workpiece and releasing the workpiece from the cylinder, the balance of the cylinder is upset as the workpiece is being released from the cylinder. As a result, the cylinder actuates. For this reason, when a workpiece must be lowered, use a cylinder with a built-in brake mechanism so that the cylinder will not actuate.
Wiring to External Equipment

**Caution**

1. **Power supply for controller**
   Supply 24V DC ± 5% and 0.4A or more for the controller.

2. **Input circuit**
   RUN2, RESET, SW, SEL, START, STOP
   
   Connect the switch or the sequence controller with 24V DC voltage and 10mA or more capacity.

3. **RUN1 input circuit at internally set operation**
   
   Connect the switch or the sequence controller with 24V DC voltage and 10mA or more capacity.

4. **RUN1 input circuit at external input operation**
   
   Connect the switch or the sequence controller with 24V DC voltage and 10mA or more capacity.

**Solenoid valve output (SOL.a, SOL.b)**

Controller (VYUS-D)

Rated voltage: 24V DC 1 Power consumption: 1.8W

**Electro-Pneumatic HYREG output (+24V, 0V, SIG)**

Controller (VYUS-D)

**Output circuit**

SET UP1, SET UP2, ERR., READY

NPN open collector output (VYUS-D)

Max 24V DC, 50mA

Note) This circuit is not necessary for READY signal.

**External appearance of exclusive controller**
Balance Controller *Series VY511/VYU5*

### Dimensions

**Valve**

**VY511-020**

Adjustable flow controller for setting

Rc1/8 Gauge port

Manual relief button

Manual supply button

4-ø4.5

**Exclusive controller**

**VYU5-D**

Rotary switch, Trimmer container

A view

### Replacement parts

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E-P HYREG valve</td>
<td>VYU1200-00-N</td>
</tr>
<tr>
<td>2</td>
<td>3 position valve</td>
<td>VEX3222-5M</td>
</tr>
</tbody>
</table>