Direct-Acting and Reverse-Acting

(My comments)
The terms "direct" and "reverse" are frequently used when discussing control valves, positioners, and controllers while writing the control narratives for the complex loops, though the definitions of direct and reverse seem pretty straightforward.

Direct action is called when the measured variable (also known as process variable PV) increases, the output increases. Reverse action is called when the measured variable increases, the output decreases.

There are three cases listed below whose combination makes a young engineer to get confused.

- **CASE I**: The fail action position of the control valve i.e. if a valve is defined when the loss of air supply/ power/ signal causes the valve to open then the valve is said to be with fail-open (FO) failure action status and if a valve is defined when the loss of air supply/ power/ signal causes the valve to close then the valve is said to be with fail-closed (FC) failure status.

- **CASE II**: The positioner of the control valve which can be set with direct or reverse action. This is up to the type of valve actuator you have chosen. I cannot see it as a different case from case I. Once you have chosen the type of actuator, you have to match the positioner action. (see my write-up).

- **CASE III**: The controller in DCS/PLC related to the control valve loop can be set as direct or reverse acting. I cannot see the point in this case. Talking about the Controller and the Control Valve – why should I care about the system architecture?

**CASE I**

While control valve bodies and control valve actuators can be described as being direct acting or reverse acting, thinking about such things when working through a system problem (along with CASE II & III) only adds to the confusion. Therefore, it is always best to consider the overall FAIL SAFE mode of the valve independent from other cases i.e. case II & III and is determined by safety considerations.

One might get a doubt that, if control signal from the DCS/PLC fail what will be the resultant fail action of the valve?

To answer the above query it is to be noted from figure 5 & 6 that the control signal is connected to the positioner and then routed to the actuator. The control signal/power supply/ instrument air failure is taken care by the positioner to set the control valve to the specified fail action position.

The below pictures give the examples of the combinations possible with the valve and actuator to get the resultant fail action position of the valve.

*Figure 1, Valve and actuator configurations*
Figure 2, Direct acting actuator and reverse acting control valve

Figure 3, Net effect of various combinations for two port valves

CASE II

Figure 4, Net effect of the two combinations for three port valves

Figure 5, A Simplified Valve Positioner Installation.
A valve positioner is a device which will accurately position a control valve in accordance with the pneumatic control signal. With a positioner, the control signal goes to the positioner instead of going directly to the valve actuator.

A valve positioner relates the input signal and the valve position, and will provide any output pressure to the actuator to satisfy this relationship, according to the requirements of the valve, and within the limitations of the maximum supply pressure.

A positioner can operate in either direct or reverse acting mode. In direct acting mode, an increase in control signal pressure causes an increase in positioner output air pressure. In reverse acting mode, an increase in control signal pressure causes a decrease in positioner output air pressure.

The below pictures show that there is an option to set a positioner with direct or indirect action.

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**Figure 6, Basic pneumatic positioner fitted to actuator pillars (valve not shown)**

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**Figure 7, A snap shot from a typical datasheet of the control valve specifying the positioner action**

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**Figure 8**
With the options available in modern DCS/PLC it is good to get the required characteristic of the control loop i.e. direct or indirect action from DCS soft controller blocks and leave the positioners of the control valve to mimic the input signal from the controller i.e., they will be DIRECT ACTING.

_{Not necessarily so – as discussed}_

**DIRECT-ACTING POSITIONER**

<table>
<thead>
<tr>
<th>Input Increases</th>
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<tbody>
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<td>Increasing Signal from Controller</td>
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Another reason the direct-acting pneumatic positioner is so popular is that it can be by-passed and the control valve will respond to the input signal from the controller as though the positioner were not in the control loop. If a positioner malfunction occurs or if the positioner causes the control valve to become unstable, it can be easily by-passed. Many control valves in the field are operating with a bypassed positioner.

The bypass switch must be used with caution. If the positioner is amplifying the control signal, operating the bypass switch will result in a lower pressure signal to be applied to the valve actuator. This will cause an erroneous valve opening. _Likewise_, when the positioner is operating in reverse mode, switching to bypass may result in the valve moving instantaneously from one extreme to the other in opposite manner then the desired one unless we have taken care to reverse the signal on the bypass. In practice, the bypass switch is often removed after the positioner has been commissioned to avoid possible confusion and misuse.

Reverse-acting positioners are sometimes used on control valves, but their appearance is rare. (As said before – it is needed whenever we use an “Air to Close” actuator!) Occasionally one will be found in a split-ranging sequence. I couldn’t find any control loop till now with reverse acting positioner action.

**REVERSE-ACTING POSITIONER**

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**CASE III**

Controllers can be set up in either direct or reverse modes. If the control valve and its controller are not in balance, the control valve will either go to the wide-open position and stay there, or it will stay closed and act as though it is not responding. This situation can normally be corrected by reversing the action of the controller.

_{I do not understand what balance you are looking for or what do you mean by the term “Balance”?}_
Direct-Acting Controller

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Reverse-Acting Controller

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Conclusion:

For easy interpretation one can assume output of the controller as OPENING of the valve.

With the above interpretation:
- Direct action of the controller is called when increase in measured variable causes increase in opening of the valve.
- Indirect action of the controller is called when increase in measured variable causes decrease in opening of the valve.

The key to working with control valves and controllers is to remember that there must always be a balance maintained in the system.

I do not understand what balance you are looking for?

If the control valve and its controller are not in balance, the control valve will either go to the wide-open position and stay there, or it will stay closed and act as though it is not responding. This situation can normally be corrected by reversing the action of the controller. For this reason the controller positioner action shall be decided by considering the valve failure status also.