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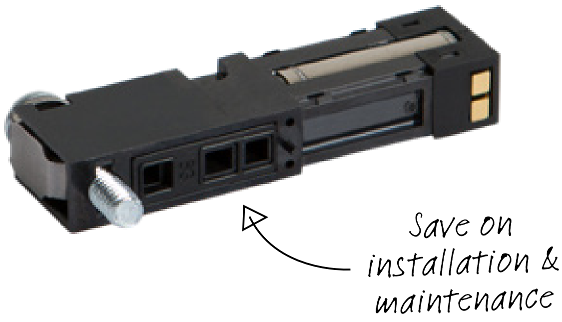
Specifying Miniature Solenoid Valves for Portable Life Science Devices

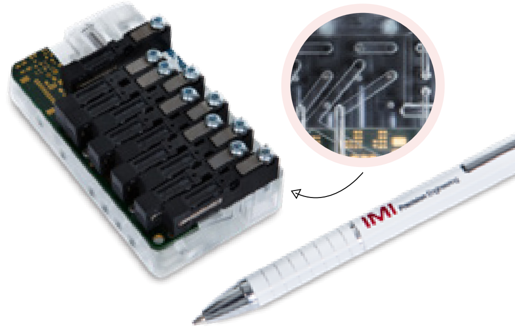
Miniature solenoid valves are critical components in portable life science equipment. Beyond the necessary long service life, medical, analytical, and point-of-care devices often require pneumatic systems with high flow rates, compact footprints, and low power consumption. Specifying solenoid valves to meet system performance needs can be challenging especially when one must consider overall system design for manufacturing.

Here we review key considerations in specifying valves to meet performance specifications and provide tips on selecting valves to improve pneumatic system design for manufacturing.



Device miniaturization: Reducing size and weight

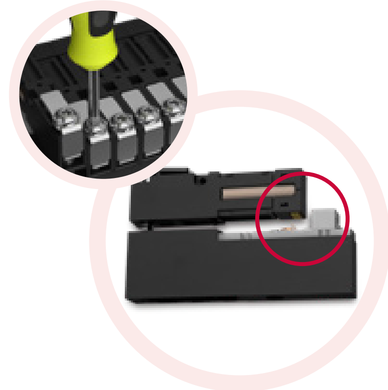
Compact size and reduced weight are key features of next generation portable life science instruments. Therefore, valve flow-to-size ratio is a critical factor when choosing valves for portable applications to enable overall system size and weight reduction. Assembling the valves directly on a manifold may help save additional space by eliminating tubing sets and connectors and optimize flow paths. Connecting the valve directly on a PCB with PAD connections will help reduce the footprint even further.



Simplified valve integration: Improving manufacturability

Design-for-manufacturing is critical to develop robust products for more demanding life science and medical applications. One of the most common errors made by designers is choosing a valve according to its technical specifications without thinking about how easily it can be incorporated into their system. To improve system design for manufacturing, reduce manufacturing costs, and improve overall quality, designers should consider these key valve features:

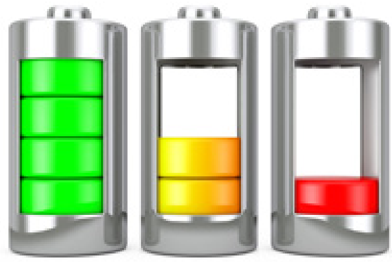
- **Fixation Screw Size:** Valve miniaturization often means smaller fixation screws. Some valves are secured with screws of sub-2mm diameters which can be difficult to handle leading to longer assembling times. Select valves with larger screws where possible for faster mounting times.
- **Number of Mounting Screws:** Mounting time is further reduced by decreasing the number of screws required to secure valves. Design innovations have recently allowed for the fixation of valves with only one screw.
- **Captive Seals:** Valves that have a captive seal prevents the loss of the seal, making valve mounting easier by avoiding misaligned seals and thus risk of leakage between the valve and the manifold.
- **PAD Connector:** Soldering or wiring the electrical connection is another source of manufacturing cost. These are tedious manual steps in manufacturing that are prone to error given their tight spaces to secure critical connections. Shielded finger contacts which can be mounted on PCBs can be used to create an electrical connection with valves having PAD connectors thereby eliminating the need for manually securing tight electrical connections in manufacturing.



Low power consumption: Extending battery life and reducing size

Portable instruments need low power consumption valves for pneumatic control to extend battery life and reduce battery size. As flow rates increase so does power demand. Choosing the right valve that delivers the highest flow to power ratio is key to optimize battery performance. New developments in valve technology offer very low power consumption options to meet these needs. To further decrease valve power consumption, designers should consider these options:

- **Pulse Width Modulation:** The power needed to open a valve is typically much higher than the power required to keep it open. Systems can provide a short momentary current boost to open the valve. Pulse with Modulation (PWM) is an effective way to minimize energy consumption. Some valves have integrated PWM technology to help simplify system design.
- **Latching Valves:** Some designers also opt for latching valves using a permanent magnet. These valves only require a momentary electrical signal to shift to the opposite state. However, due to their limited environmental tolerances of vibration, humidity, temperature range, and electromagnetic interference as well as a higher price, they tend to be limited to niche applications.



Valve longevity: Saving on maintenance

Long service life for valves is essential in medical and diagnostic applications where failures can have serious consequences.

Extending valve life starts with selecting chemically compatible wetted materials; especially the dynamic internal seal which is often the first part to fail in solenoid valves. The incorrect selection of the seal material can lead to swelling of the seal and valve leakage. Although life cycles are generally disclosed in product datasheets, this is dependent on environmental conditions including not just media but pressure and temperature conditions as well. Therefore, a complete working environment assessment is necessary. For example, FFKM seals have excellent chemical compatibility but tend to have reduced lifecycles when used at low temperatures. Multiple environmental factors need to be considered when evaluating valve designs for extended system life expectancy.

Conclusion

Portable life science devices are becoming more compact and require more complex fluidic systems. This trend amplifies the need for small footprint solenoid valves with low power consumption and high flow rates to reduce battery and overall system size. Valves designed for easy integration reduce system assembly time, and improve system quality. Specifying valves for these systems can be challenging, but valve technology advancements in flow to power ratio and mounting simplification can address these challenges.

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