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VHS® VALVE EVALUATION KIT

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1. VHS® VALVE EVALUATION KIT OVERVIEW

This kit is designed to assist in the development of micro dispensing systems by providing essential components. The heart of this kit is the VHS Series 2-Way Dispense Solenoid Valve. The standard valve offers a broad range of chemical compatibility, extremely fast response, and incredible stability allowing for reproducible and repeatable dispenses.

Within this document, recommendations and best practices will be offered as guidelines for preferred micro dispensing systems. For any additional information regarding optimizations or added recommendations beyond the scope of the document, please contact your respective sales representative for more information and guidance.

Kit Contents:

Part Number	Description
INKX0514300A	VHS Series 2-Way Dispense Solenoid Valve (M/M Configuration, EPDM Seal)
IECX0501350A	Spike and Hold Driver
INZA4710975H	Dispense Nozzle: 062 MINSTAC® ,Ø .010” Orifice
INZA4670915K	Dispense Nozzle: 062 MINSTAC Ø .0075”, Orifice
INZA4650935K	Dispense Nozzle: 062 MINSTAC Ø .005”, Orifice
IAZA1200122K	Atomizing Nozzle: MINSTAC, 22K Lohm Rate
INMX0350000A	Safety Screen Filter: 062 MINSTAC ,12 µm
TMDA3212950Z	Adapter: 062 MINSTAC Female to ¼-28 Flat Bottom Female
TMDA3201950A	Adapter: 062 MINSTAC Female to Barb for 1/16” ID Soft Tubing
TUTC3216930L	Tubing Assembly: 062 MINSTAC, 2x Fittings, 30 cm Long, 0.032” ID
TTTA3201243A	MINSTAC® Torque Wrench
IHWX0248120A	24” Lead Wire Assembly
IHWX0290550A	Valve Mounting Clip

2. KIT COMPONENTS

The VHS® Evaluation Kit is designed to provide all the specialized hardware necessary to setup and run a dispensing system for small volumes ranging from 500 microliters down to 20 nanoliters. The components included within this kit were chosen to cover a broad range of applications.

VHS Series 2-Way Dispense Solenoid Valve (INKX0514300A)

VHS valves are designed for high precision dispensing applications in the nanoliter, microliter and milliliter ranges, with remarkable repeatability across a long life. The INKX0514300A (Valve Configuration M/M) has a threaded 062 MINSTAC inlet and a threaded 062 MINSTAC outlet, providing simple, interchangeable connections on both sides to our leak proof system of MINSTAC tubing, nozzles, and components. This interchangeability enables rapid prototyping and design iteration with various orifices sizes, nozzle types and tubing lengths. This valve's EPDM elastomeric seal is compatible with many commonly used fluids.

The INKX0514300A VHS valve supplied with the kit is for general proof of concept and is just one of many standard valve part numbers readily available. The Lee Company also offers numerous valve options to suit a variety of dispense needs, including alternate inlet and outlet fluidic connections, seal materials, dispense orifice sizes (outlet), nozzles, and drive voltages. The Lee Company can also customize valve design for specific application parameters.

Spike and Hold Driver (IECX0501350A)

VHS valves require a spike and hold electrical drive. If the voltage is not reduced after the initial spike, the coil of the valve will overheat and can permanently damage the valve. The Spike and Hold Driver provides the proper waveform for safe and repeatable valve operation. It will apply the spike voltage and then drop it to the required hold voltage. The user must still provide the power supply to the driver and control signal for proper valve operation.

062 MINSTAC Precision Dispensing Nozzles:

- INZA4710975H (Ø .010")
- INZA4670915K (Ø .0075")
- INZA4650935K (Ø .005")

These 062 MINSTAC nozzles incorporate precision sapphire orifices. Three dispensing nozzles with three different orifice diameters are included in the kit to allow the user to change the flow range by simply threading in a different size nozzle. The INZA4670915K nozzle represents the benefits of coating the nozzle with PTFE to reduce surface energy and potential flooding at the dispense tip. The threaded design also allows cleaning of the nozzle. The output from these nozzles can be a steady stream or individual droplets depending on the duty cycle and on-time of the valve. Additional orifice sizes, tube lengths and dispensing nozzle configurations are available.

062 MINSTAC Airless Atomizing Nozzle (IAZA1200122K)
The airless atomizing nozzle provides an atomizing effect when used with the VHS® valve to produce a 50° hollow spray cone without the need of an external air source. The recommended pressure for atomization is 30 psig.

062 MINSTAC Safety Screen Filter (INMX0350000A)
The 12-micron PEEK safety screen is for “last chance” protection of the valve. The screen should be installed directly into the inlet of the valve prior to usage. The screen will capture any loose particles that may be present in the fluid system that could lead to leakage or premature valve failure. The screen is not meant to replace system filtration or proper system cleanliness procedures.

062 MINSTAC 30 cm Tubing Assembly (TUTC3216930L)
The 30 cm long 062 MINSTAC PTFE tubing assembly is used to connect the valve to the fluid supply. This assembly has an 0.032” ID (0.81 mm) and is provided with 062 MINSTAC® connections at both ends for ease of installation. Additional tubing lengths, inner diameters, and fitting configurations are also available off-the-shelf and as customs to adapt to your specific fluidic setup.

062 MINSTAC to ¼-28 Flat Bottom Adapter (TMDA3212950Z)
The TMDA3212950Z PEEK adapter allows The Lee Company’s 062 MINSTAC tubing assemblies to connect directly with alternate tubing systems using ¼-28 flat bottom fittings.

062 MINSTAC To Soft Tubing Adapter (TMDA3201950A)
This adapter allows the VHS valve with 062 MINSTAC to be used with 1/16” soft tubing on the inlet port of the valve.

062 MINSTAC Torque Wrench (TTTA3201243A)
The wrench is used to tighten the 062 MINSTAC nozzles and fittings to the proper torque values.

Lead Wire Assembly (IHWX0248120A)
IHWX0248120A is a high retention 24” long 24 AWG PTFE lead wire assembly that comes with female connectors in a polyphenylene oxide (PPO) housing. The lead wire assembly is used to connect the .025” square x .100” on-center pins of the VHS® valve to the terminals of the Spike and Hold Driver.

Valve Mounting Clip (IHWX0290550A)
The mounting clip offers a convenient way to surface mount VHS valves for development purposes. For alternate mounting options, including mounting sleeves for Manifold Mount VHS designs, please visit our website our contact us.

3. DISPENSE CONSIDERATIONS

The dispensed volume of fluid is influenced by several factors:

- Fluid properties (viscosity, surface tension, etc.)
- Orifice diameter
- Valve on-time
- Inlet pressure and pressure source

The orifice selection, valve on-time, and system pressure will be determined by the properties of the fluid dispensed and the target dispense volume.

An orifice, or nozzle, should be selected and tested to determine if it is within the proper flow range. Once the orifice is selected, the valve on-time and system pressure will determine the volume dispensed. Using larger or smaller orifice sizes will increase or decrease the dispensed volume, respectively.

The inlet pressure directly affects the volume dispensed. Determining the preferred combination of pressure and on-time will sometimes require several trials. If the pressure is increased, the dispensed volume increases proportionately. For fluids similar to water in viscosity, a starting pressure of 2 and 5 psig is recommended and can be increased from there to achieve desired output

The on-time of the valve significantly impacts dispense volume and dispense morphology, such as dispensing droplets or a stream. For droplet dispensing, shorter on-times are used to quickly power the valve to open. The longer the valve is open, more volume will be dispensed through the outlet. This would be the case for dispensing larger volumes, or streams. A longer on-time will be needed for higher volumes.

Higher viscosity fluids can be used with the VHS valve, but there are few factors to consider. Using more viscous fluids with higher surface tension typically will have an affect on droplet formation, such as jetting and hanging droplets, and will typically require a longer on-time to extrude through the outlet port of the valve. Using significantly viscous fluids above 30 centipoises will have difficulty being dispensed.

The fluid must also be compatible with the wetted components of the system. The VHS supplied with this kit, INKX0514300A, incorporates an EPDM sealing surface. Other sealing materials are available (SI, FKM, FFKM). Before beginning any micro dispensing application, please ensure all drawing notes for materials in the wetted path of the valve will be compatible with the fluids flowing through.

Upon request, material samples may be provided to conduct chemical compatibility testing. Please contact your local sales representative for more information.

4. SYSTEM CONSIDERATIONS

I. Pressure

The valve must be connected to a pressurized reservoir to allow fluids to flow. Pressure is a significant aspect of dispensing systems. The user must provide the steady-state pressure source required for consistent and repeatable dispenses. Any fluctuations in pressure will directly affect the dispensed volume.

The pressure needed will depend greatly on the fluid properties of the liquid being dispensed. If the pressure is set lower, the droplet will have a reduced velocity from the dispense tip. Fluid will begin to collect at the tip and dispense volumes will become very erratic. There may be several dispenses where no drops leave the tip, but also dispense events where there will be a large volume dispensed from accumulating over time. If the pressure is set higher, the fluid will tend to splash with increased velocities as the fluid contacts the substrate.

The Lee Company provides a range of products for direct or indirect liquid handling. While unable to handle liquid directly, our pneumatic piezoelectric disc pumps are ideal for pressure-driven flow systems, including time metered dosing, micro dispensing systems. In these systems, the pump pressurizes a known volume of air, the head pressure, above the pressurized liquid in a fixed reservoir. The disc pumps' infinite turn down ratio and pulsation-free, vibration-free operation, result in ultra fine resolution control of the pressure in your micro dispensing system. For additional information please contact us or visit our website.

II. Fluidic System Cleanliness

Contamination is the highest cause of valve failure. Most initial startup failures are caused by contaminants in system components that are used for the first time. This will appear as leakage, or in some cases no flow, resulting from the valve being unable to fully seal. Fluidic systems that dispense small volumes rely on components with very tight clearances, such as the valve passageways or a nozzle. These components require a high degree of system filtration and cleanliness to ensure repeatable dispenses. There are two components to proper system cleanliness:

- The first component is filtration. The user either provides fluid that is pre-filtered, 12 microns or finer, or installs a system filter. The system filter must have a rating that is compatible with the downstream components and must have enough open area to prevent clogging. The cleaner the initial fluid, the smaller the filter open area required. If the fluid contains too much particulate material, the filter will clog rapidly.
- The second commonly overlooked component is housekeeping during assembly. It is possible to have a properly filtered system and still experience contamination problems. The contamination may be present in the individual components or can be introduced during assembly. Extra precaution should be taken to ensure all components are free of Foreign Object Debris (FOD) during assembly of the dispensing system.

All system components, including the filter, should be thoroughly flushed with clean fluid prior to assembly. This will remove loose debris, fibers or dust particles that may exist. Afterwards, the system can be assembled starting from the fluid reservoir where flushing should be conducted

as each component is added. This process will remove contamination that is introduced during the assembly process, which can include burrs from tubing, pieces of sealant (Such as Teflon tape), and debris from sintered filters. Lastly, the valve and nozzle may be added once the entire system has been allowed to flush for a period of a few minutes.

Care should also be taken when using fluids that are prone to crystallization. These should not be allowed to dry out in the valve and nozzle. The system should be flushed with a clean liquid prior to storage.

The use of "last chance" safety screens will reduce valve failure due to contamination inadvertently introduced over the life of the valve but should be used in conjunction with proper system filtration.

III. Valve System Purging

Reliable and repeatable performance can only be achieved after the entire system has been thoroughly purged of air. This requires both static and dynamic purging to ensure that all air bubbles are removed.

The initial purge should be a static purge that allows the valve to flow at full capacity. This will remove the greatest amount of air in the shortest amount of time. Here are the preferred steps to the purging routines:

- **Static Purge**: The valve should be held open for a minimum of 10 seconds with pressurized fluid attached to the inlet (10 psi is recommended, but system pressure can be used if necessary. Lower pressure may increase the required on-time). The valve can be held open either mechanically (place a magnet on the valve coil) or electrically. If the valve is held open electrically, it is critical to reduce the signal to the hold voltage after the initial spike. Failure to do so will damage the valve.

- **Dynamic Purge**: A dynamic purge will remove the remaining bubbles that may be attached to the internal surfaces of the system. Cycling is required due to different size bubbles “breaking off” at different frequencies. This is performed by cycling the valve at 100 Hz, 150 Hz, 200 Hz and so on up to 500 Hz for 5 seconds at each frequency for 2 complete cycles. Following the dynamic purge, a test dispense should be conducted. Depending on the system pressure and configuration, the cycle may need to be repeated. The valve should be ramped through its dynamic response range.

If the system is allowed to sit for extended periods of time, the purging sequence may need to be repeated. This is due to air entrained in the fluid coming out of solution. Degassing the fluid may prevent this or extend the time between purging.

5. FLUIDIC CONNECTIONS

When setting up micro dispensing systems, the tubing connections should be as short as possible, and the user must ensure that all fittings and nozzles are properly tightened. Failure to do so can result in leakage or air entering the system. These conditions will affect the accuracy and repeatability of the dispensed volumes. The MINSTAC nozzle should be threaded directly into the outlet port of the valve.

The MINSTAC Tubing Assembly (TUTC3216930L) is used to connect the valve inlet to a pressurized fluid source. This tubing assembly will allow the valve to be used with pressures of up to 120 psig. A ¼-28 adapter is provided to allow connections to other fitting systems. Additional MINSTAC components are available to connect to a variety of fluid reservoirs.

The “soft tube adapter” (TMDA3201950A) can be threaded into the inlet side of the VHS® valve. This allows the use of 1/16” ID soft tubing (i.e. PVC) on the inlet side. When soft tubing is used, pressure must be limited to 30 psig for retention.

6. ELECTRICAL CONNECTIONS

The VHS Evaluation Kit provides most of the needed components for dispensing, but to facilitate the dispense, the user will be required to provide the following:

- 24 vdc power supply (20-watt minimum) to supply the spike voltage
- 3.2 vdc power supply (2-watt minimum) for hold voltage
  5 vdc source of on-off control signal (Function generator)

The VHS valve requires a voltage spike to actuate. For instance, the valve provided in this kit, INKX0514300A, will require a minimum spike duration of .35 ms at 24 vdc. The initial voltage spike is too high to allow continuous operation of the valve and must be reduced immediately after the valve has been actuated. If the voltage is not reduced, the valve will overheat and experience permanent damage. To ensure a proper drive, please reference all notes on the respective valve drawing.

The Spike and Hold Driver (IECX0501350A) provides a safe operating voltage profile for the VHS valves by converting a TTL control signal into a spike and hold voltage. The driver also assists in ensures precise fluid dispenses with the valve. On the driver itself, there are terminals that allow for the polarized valve connections, spike voltage, hold voltage, control voltage, and ground to safely drive the valve with a streamlined interface.

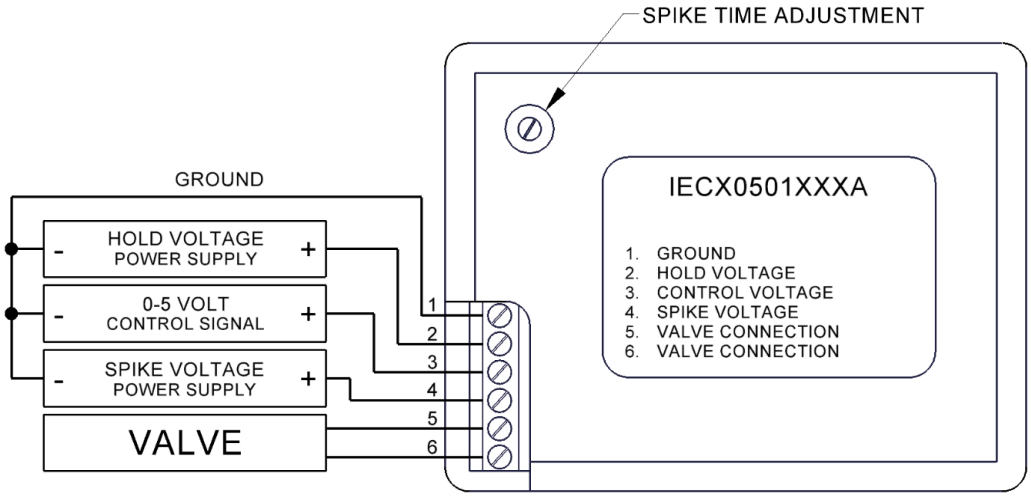

Figure 1: VHS Spike & Hold Driver with terminals.

The VHS® valve pins are .025” square x .100” on center, tin coated phosphorus bronze, bent 90° to the valve body. Longer pins and other custom bends are available through special order. The lead wire assembly (IHWX0248120A) utilizes 24 AWG PTFE insulated wire with high retention female connectors in a polyphenylene oxide (PPO) housing and can be used to attach to the pins of the valve.

Specific information can be found within the Spike & Hold driver instructions under document INIX0500200A. Recommendations and preferences regarding equipment can be provided by The Lee Company. Please contact your local sales representative if needed.