Industrial R-DDV® Servovalve Frequently asked Questions

1. Is the R-DDV® Servovalve interchangeable with existing servovalves?
The Woodward HRT R-DDV® Servovalve can be used to replace most existing Servovalves. For many applications an adapter plate is required. Refer to the interchangeability chart to determine if an adapter plate is required. See question #3 for electric power supply requirements.

2. Does the motor to spool interface wear?
The eccentric drive to spool interface incorporates 440C and tungsten carbide materials, and is proven and in thousands of customer applications. The typical life of interface before wear significantly affects the performance is over well 100 million full stroke cycles. In one customer application, an R-DDV® Servovalve demonstrated acceptable performance to over 500 million cycles in an endurance test system.

3. What is the power supply requirement?
The recommended power supply is 24 V (± 0.5 V), 2 A minimum. The valve peak current is 2 A although the average current use will be much less. The peak current (2A) is only required to shear contamination between the spool and housing (chip shear) or during extreme dynamic operation. The actual average current required is a function of the system pressure and system dynamics.

4. What supporting electronics is available?
Woodward HRT offers control cards to use with the R-DDV® Servovalve to complete a servo system. The control cards are used to close the loop in the servo system. There are currently four versions available. See "Control Electronics" section.

5. What is the valve null lap condition?
Lap condition affects the valve's flow characteristics through the null, or "no flow", region. Physically, it is the relationship between the flow control edges on the sliding spool and the flow control edges in the fixed housing.

When a "perfectly" zero-lapped valve is commanded to null, all control edges on the spool would be inline with the all control edges found in the housing. Any small movement of the spool will immediately cause flow to occur in the relative control ports. The ratio of flow vs. command for a perfectly zero-lapped valve will be the same through the null region as it is for the remainder of the valve.

In the case where an underlapped valve is commanded to null, there will exist a small gap between the spool edges and the housing edges. This results in the control ports being slightly open to the pressure and return ports while at null. Any movement of the spool will cause flow to occur through the ports; however, the ratio of flow vs. command for this valve will be larger through the null region than is for the remainder of the valve.

Likewise when an overlapped valve is command to null, there will also be a small distances between spool and housing edges. However, in this case flow between ports is blocked by the annular clearance between the spool and the housing bore. Again, Any movement of the spool will cause flow to occur through the ports; however, the
ratio of flow vs. command for this valve will be smaller through the null region than is for the remainder of the valve.

6. Can the valve be used in 2-way, 3-way, 4-way flow control?
The valve may be used to provide flow control in any one of these configurations. Typically, the valve is furnished with four flow ports; one inlet for source pressure (P), two for flow control (A & B), and one for fluid return to the system tank (T). By connecting the valve to the system by various methods, the required flow configuration may be obtained. A few examples of this are given below:

4-Way Flow
For applications that require control over the motion and position of a double acting linear or rotary actuator, connect:

Pressure port P to system supply pressure.

Control port A to the applicable actuator port (i.e. Cylinder extend).

Control port B to the remaining actuator port (i.e. Cylinder retract).

Return port T to the system return, or tank.

For a given command flow will be P >>> A and B >>> T, or P >>> B and A >>> T.

3-Way Flow
For applications that require diverting flow direction from one part of the system to another, connect:

Pressure port P to system supply pressure.

Control port A to the applicable system branch.

Control port B to the remaining system branch.

Cap return port T.

For a given command flow will be P >>> A or P >>> B.

For applications that require control over the motion and position of a single acting linear or rotary actuator, connect:

Pressure port P to system supply pressure.

Either control port (i.e. A) to the actuator port.

Cap the remaining control port (i.e. B).

Return port T to the system return, or tank.
For a given command flow will be $P \ggg A$ or $A \ggg T$.

**2-Way Flow**
For flow throttling applications, connect:

Pressure port $P$ to the upstream supply line.

Either control port (i.e. $A$) to the downstream line.

Cap the remaining control port (i.e. $B$).

Cap return port $T$.

For a given command flow will be $P \ggg A$.

An optional configuration, that doubles flow capacity, would be to connect:

Pressure port $P$ to the upstream supply line.

Control port $A$ to the downstream line.

Control port $B$ to the upstream supply line.

Return port $T$ to the downstream line.

For a given command flow will be $P \ggg A$ and $B \ggg T$.

**7. Describe the operation of the R-DDV® Servovalve.**
The Woodward HRT Rotary Direct Drive R-DDV® Servovalve is a straightforward design. A limited angle, rotary torque motor drives the spool directly through an eccentric which is built into the motor shaft. Rotary operation of the motor results in linear spool motion, which modulates the flow of air from the pressure ($P$) port through the cylinder ($A$ and $B$) ports of the valve. Flow is then ported to one of the two return (R) ports.

The R-DDV® Servovalve requires an electronic controller, which is integrated into the valve. This controller compares the command input signal with actual spool position, which is monitored by an electronic device within the torque motor.

The controller then generates a current signal to drive the motor to the commanded position. The signal is enhanced by electronics for optimum valve performance.

**8. Can the valve be used for pressure control?**
The valve can be used for pressure control in two ways, open or closed loop. In either case the valve must be configured for two or three way flow depending on the system architecture.
Open loop — For *constant* load flows in or out the volume to be controlled, the valve can be used as a pressure control by setting the command to provide flow into or out of the volume to achieve the desired pressure. (Requires a valve command signal only).

Closed loop — For varying load flows in or out of the volume to be controlled, an electronic card (i.e. EC250-000) can be used to close the loop on the signal from a pressure transducer. The electronic card varies the valve’s flow command depending on the difference between the pressure command signal and pressure feedback signal from the transducer. The PID control parameters on the electronic card and the load dynamics determine the accuracy, speed of response, and stability of the system in response to command changes and load disturbances. (Requires pressure transducer and loop closure electronics)

9. What fluids can be used with R-DDV® Servovalve?
The R-DDV® Servovalve is compatible with virtually all hydraulic oils, gases (including air), and most other non-conventional fluids. Applications using phosphate ester hydraulic fluid and water should be discussed with Woodward HRT sales engineers or factory technical staff to verify compatibility. For most fluids, the standard R-DDV® Servovalve nitrile seal material is excellent, while other fluid mediums may dictate the use of Viton® or Ethylene Propylene seals, which are available. The R-DDV® Servovalve’s high dynamic response is consistent with any fluid medium, regardless of the operational pressure, being that the valve is driven by an electromechanical motor, as opposed to a hydraulic power stage.

10. What system cleanliness does the R-DDV® Servovalve require?
As with any Servovalve, the life of the R-DDV® Servovalve is enhanced by the cleanliness of the operating fluid. Being that the R-DDV™ Servovalve has no filters or small orifices, it is much more tolerant to fluid contamination than is a standard Servovalve. For best results, hydraulic fluid should be filtered to ISO 4406 16/13 or better. Pneumatic systems work best with clean lubricated air, 5 micron or better filtration.

11. What materials are used in the R-DDV® Servovalve?
The R-DDV® Servovalve is constructed of materials proven in Servovalve applications for more than 50 years. The valve housing and spool are made from heat treated 440C stainless steel for strength, corrosion resistance, and wear characteristics. Likewise, all the internal motor parts exposed to the operating fluid are made from corrosion resistant materials or are protected by a protective coating. The connection between the motor and the spool is a modified tungsten carbide, and has been successfully endurance tested to well over 100 million full stroke cycles. Materials exposed to the external environment have surface treatments to enhance corrosion resistance: anodized aluminum, plating or black oxide for alloy steels, and engineered plastics to house the integrated controller.

12. What is the operating environment? (temperature, pressure, vibration, shock)
**Temperature:**
The recommended operating temperature range is between —40ºF to 160ºF (-40ºC to 70ºC), which is generally adequate for most industrial applications. The upper end of this temperature range is primarily dictated by the electronics in the integrated controller. Since the controller is not directly exposed to the operating fluid and is more affected by the ambient temperature than the fluid temperature, fluid temperatures can be allowed to exceed this range in many instances, provided that measures are taken to keep the electrical controller temperature within the recommended range.
Pressure:
The R-DDV® Servovalve pressure rating has two considerations: 1) the rating as a pressure vessel, i.e. the maximum safe operating pressure with safety factors for proof and burst, and 2) the flowing differential pressure rating.

**Pressure Vessel Rating.** The R-DDV® Servovalve products are offered in three pressure ranges: 5000 psi, 1000 psi, and a pneumatic line at 150 psi. Woodward HRT conducts a proof pressure test at 1.5 times the pressure rating on the supply and control ports; and 1.0 times the pressure rating on the tank port for each unit shipped.

**Differential Pressure Rating for Flow.** Woodward HRT’s advertised maximum pressure rating is the differential pressure at which the valve can maintain continuous wide-open flow at a power supply current draw of less than 1 amp. This is a conservative rating, considering that the R-DDV® Servovalve is generally capable of using up to 2 amps from the power supply when the demand is present. Generally, the valves can operate at higher pressures and / or flows than the advertised rating, for operating conditions other than continuous wide-open flow. Please contact Woodward HRT technical assistance if your requirements are outside of the range of the advertised operating conditions.

**Vibration and Shock:** Each of the R-DDV® Servovalve hydraulic product lines has been qualification tested to 60 g’s shock and to 40 g’s vibration per MIL-STD-810 on all three axes.

13. Does the R-DDV® Servovalve Null Shifts With Temperature or Pressure:
The R-DDV® Servovalve null characteristic is extremely stable throughout the entire temperature and pressure operating range, with a null bias less than 1% of rated command under all conditions.

14. What flow rates are available?
Woodward HRT uses the standard industrial convention of specifying hydraulic flow rates (4-way flow) at 1000 psid, when tested using hydraulic fluid with a specific gravity of .85, unless otherwise stated. This flow rate, or pressure differential, can be converted to other operating conditions, using the following formula:

\[
Q = Q_R \times \sqrt{\left(\frac{P \times SG}{PR \times 0.85}\right)}
\]

Where:

\(Q\) = Flow at new condition

\(P\) = Differential Pressure at new condition

\(SG\) = Specific Gravity of new fluid

\(PR\) = Rated Differential Pressure

\(Q_R\) = Rated Flow

Pneumatic 4-way flow rates are for supply air at 100 psig, vented to atmosphere. Pneumatic flow rates at other operating conditions can be converted as well — please consult with Woodward HRT technical assistance.

15. What electrical commands are available?
16. What is the valve porting interface?
The R-DDV® Servovalve porting and interface dimensions for our existing products will soon be featured at this web site. Please call Woodward HRT for information. Currently, we are developing other models to be released in the near future with D03 and D07 mounting (per ISO 4401).

17. What is the valve electrical interface?
See R-DDV® Servovalve model specification sheets for available input command options

18. Is a dither signal required?
Woodward HRT’s R-DDV® Servovalves have no need for dither, and therefore we do not recommend it for use on our valves.

Dither can be defined as a small amplitude sinusoidal signal in the frequency range typically from 60 — 400 Hz that is superimposed on the servo valve input signal. The purpose of dither historically has been to "wash-out" valve hysteresis and threshold anomalies — e.g. magnetic hysteresis, spool threshold, poor spool-lap, or to limit the accumulation of silt on spools in dirty oil systems. Dither is essentially a trade-off: improved performance at the expense of reduced product life due to the high cycle count.

Being that the R-DDV® Servovalve design uses a high gain integrated electronic controller that continuously monitors and corrects the internal position of the valve, hysteresis and threshold are typically extremely low by Servovalve standards, and thus the dither "band-aid" is not required. Since dither is not required to enhance performance, the customer’s drive electronics is simplified, and the product cycle life is maximized.

19. What happens upon loss of electrical signals? What failsafe options are available?

1. Loss of command signal: The valve will immediately move to the Zero command position as follows:

   Zero-bias valves (command designators 01, 06 through 09 and 11 through 17) for these valves the zero command position is zero flow (+/-1%)

   Biased valves (command designators 05 and 10) for these valves the zero command position is wide open flow from P to port B (C2), with port A (C1) wide open to T (return)

2. Loss of 24VDC power supply:

   Loss of power supply basically means the only forces acting on the valve spool are hydraulic flow forces and friction. For most of our valves, this force of the flowing fluid will tend to close the spool, or move the spool toward a closed position.

   Exceptions are valves that have a very low flow force, such as:
Valves rated for 0.4 GPM or less: the flow forces are lower than the viscous friction of the spool or the magnetic cogging of the drive motor.

Valves operating in a low-pressure system, such as 100 PSIG air or 100 PSI oil.

The 15GPM version of model 27E: This valve has essentially Zero Flow force throughout its entire operation at any operating pressure.

In the above three examples, A, B and C, upon loss of the 24 volt power supply signal, the spool would merely stay at whatever was the last commanded position before the power was lost, unless vibration caused the spool to migrate to some other position.

We have incorporated a "bias spring" into modifications of models 27E and 27G, which can be mechanically adjusted to cause the spool to be shoved over toward a wide-open flow position upon loss of power supply. We have not had orders to build "bias spring” features into model 27A.

The effectiveness of bias springs depends upon the flow forces and operating pressures. The balance of the spring force and the flow forces may occur at some spool stroke other than wide open flow.

20. Can the valve null be adjusted?
Valve null is adjusted using precision 4-way flow cylinders during final Assembly and Test at Woodward HRT. Each valve is set to achieve zero flow at the specified null command signal within ±1%. This setting is virtually unaffected by environmental parameters (such as inlet and return pressure, fluid and ambient temperature, vibration, and shock) because of the integrated electronic controller that continuously monitors and corrects the internal position of the valve.

An added benefit of the valve's internal electronic control loop is that valves can be built with an apparent Zero-lap null by combining an overlapped spool with the appropriate matching electronic controller gain to achieve a linearized flow gain through null. This manufacturing approach eliminates costly flow-grind procedures, and offers exceptionally low internal leakage for the customer. Since the valve null setting is a combination of two adjustments (Zero-bias and linearity), we recommend that customers not alter the factory null setting unless their system performance indicates that a null bias correction is necessary.

Woodward HRT recognizes that many customer applications require specific valve null characteristics, and quite often require a fine-tune null adjustment of the valve to optimize their system performance. In addition to the standard valve null described above, Woodward HRT offers zero-lap, overlap, and underlap options to suit the customers’ needs. We suggest that each application be carefully reviewed with the Woodward HRT distributor or sales / technical staff to ensure that the proper null specification is selected for the application.