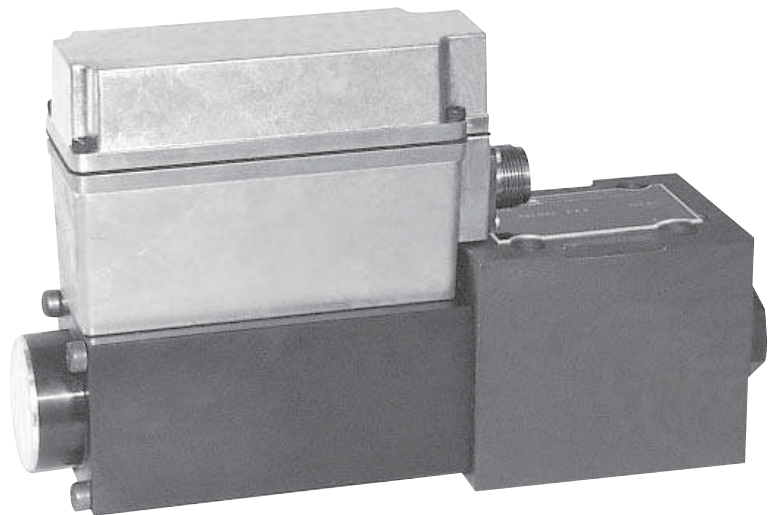
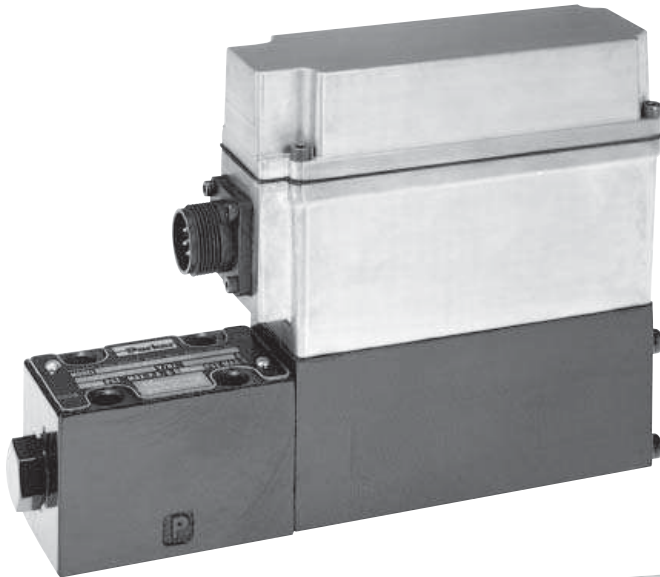




**Bulletin HY14-2599-M1/US
Installation Guide**

**Series D*FH / D*FM
Proportional Directional
Control Valves**

Effective: June 15, 2004
Supersedes: Bul. HY14-2579-M1/US dated 2/1/01
Bul. 2596-M1/USA dated 4/1/00
Bul. 2592-M1/USA dated 7/21/97



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General Description

Parker Series D*FH is a high response, proportional servovalve with an on-board drive amplifier. The D*FM is a high response, direct actuated servovalve with high resolution around low command inputs. The D*FM is designed for more precise control of position loops, force loops, and machine tool feed rates.

Series D*FH and D*FM incorporate the use of state-of-the-art drive electronics with an LVDT for continuous monitoring of the spool position. Zero lap spools are standard for closed loop applications with two different 'power down' configurations. The valves feature frequency response levels greater than 100 Hz for D1FH and D1FM, and 45 Hz for D3FH and D3FM, along with low hysteresis and excellent repeatability.

Operation

Series D*FH

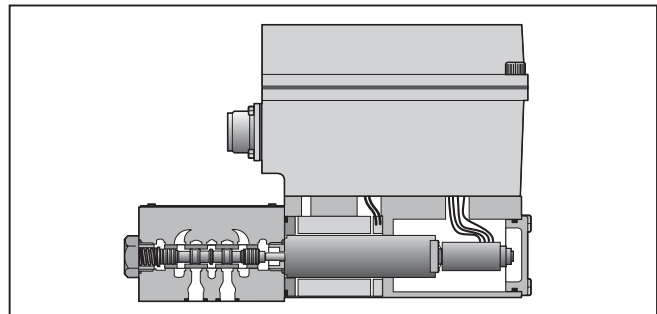
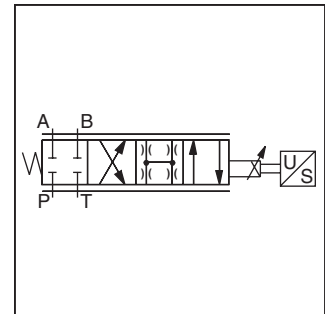
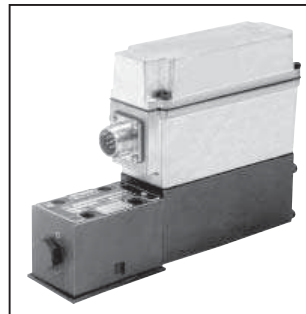
Series D*FH valve uses a precision lapped spool and sleeve configured with four control positions. During normal operation, the valve will shift from the center position to either side providing flow out the 'A' or 'B' port. When the drive amplifier is disabled by either removing the enable or loss of electrical power, the valve will shift through P→B in less than 10ms to a fourth position. The fourth position will block all four ports in one version. A second version that is available will block the 'P' port and allow the 'A' and 'B' ports to bleed to the 'T' (tank line). (Refer to the "Flow With No Enable" in Troubleshooting section)

Series D*FM

The high resolution Series D*FM adds hydraulic and electronic control compensation to the standard D*FH valve. This feature enhances the tuning and accuracy of systems utilizing high resolution feedback transducers and control compensation available in high performance motion controllers. The D*FM valve uses a precision lapped spool and sleeve configured with four control positions. The fourth position (disabled) is available in an all ports blocked configuration or 'A' and 'B' ports bleed to tank configuration.

Note:

The tank line of either style valve must have a minimum pressure of 1.4 Bar (20 PSI). Maximum tank line pressure is 35 Bar (500 PSI).



Features

- **On-Board Electronic Drive Amplifier** — The unit is shipped as a factory preset and tested unit. (No adjustment is necessary)
- **High Frequency Response** — The valve has a very high frequency response which is necessary for many closed loop applications.
- **Four Position Spool Capability** — The four position spool provides predictable flow in the event of a power failure to the drive electronics, within the limits of the power curve.
- **315 Bar Pressure Capability** — The maximum operating pressure rating for the D*FH and D*FM is 315 Bar or 4500 PSI (Port P, A, B).
- **Spool Position Feedback** — The LVDT continuous feedback monitoring circuit provides low hysteresis and excellent repeatability.
- **Drive Enable Feature** — Output to the coil is shut down when the enable signal (10 to 30 VDC) is not present. The valve will then shift to the fourth position flow path selected by the user. (E50 or E80 spool)
(Caution: Read "Flow With No Enable" in Troubleshooting section)
- **High Resolution Around Null** — For precise control of critical position, force, or feed rates (D*FM Version only)
- **Cylinder Ratio Adjust** — To match following error on extend and retract. (D*FM Version only)

Specifications

	D1FH, D1FM	D3FH, D3FM	
Interface	NFPA D03, CETOP 3, NG 06	NFPA D05, CETOP 5, NG 10	
Flow Rating At 35 Bar ΔP (500 PSI) per metering edge	¹⁾ B spool 5 LPM (1.3 GPM) ¹⁾ D spool 10 LPM (2.6 GPM) ¹⁾ H spool 20 LPM (5.3 GPM) ^{1,2)} M spool 40 LPM (10.6 GPM) ²⁾ F spool 12 LPM (3.2 GPM)	¹⁾ P spool 50 LPM (13.2 GPM) ^{1,2)} Y spool 100 LPM (26.4 GPM)	
Frequency Response	> 100 Hz (-3 dB at 5% signal)	> 45Hz (-3 dB at 5% signal)	
Step Response	< 12 ms at 100% signal	< 25 ms at 100% signal	
Power Consumption	40 VA max (See voltage supply)	60 VA max (See voltage supply)	
D1FH, D1FM, D3FH, D3FM			
Max. Operating Press. Port P, A, B Port T	315 Bar (4500 PSI) 35 Bar (500 PSI)	Operating Temp. Range (Ambient) 0 to 60° C (32 to 140° F)	
	Min. Tank Line Press. 1.4 Bar (20 PSI)	Fluid Cleanliness Level	ISO Class 15/12/10 (For longer life) ISO Class 16/14/11 (For normal operation)
Typical Spool Overlap Zero Lap		Voltage Supply	24 VDC (21 VDC Min., 30 VDC Max.) Peak Current 4A (PS24 power supply recommended)
Pressure Gain % of Change/1% Change in Command	¹⁾ Typical 40% ¹⁾ Minimum 25% ²⁾ Typical 90%	Command Signals	± 10 VDC at 100 K ohm input impedance ± 20 mA at 499 ohm input impedance
Hysteresis	< 0.5%	Protection Class	IP65, NEMA 4 (As factory sealed)
Repeatability	< 0.5%		
Viscosity Range	17 to 65 cSt (75 to 300 SSU)		
Fluids	Mineral base hydraulic fluid		

Note: 1) D*FH only 2) D*FM only

Maximum Flow and Pressure Differential

Spool Code		Flow Code						
		B	D	F	H	M	P	Y
E50	Max ΔP Per Land	100 Bar (1500 PSI)	100 Bar (1500 PSI)	60 Bar (850 PSI)	70 Bar (1000 PSI)	52 Bar (750 PSI)	70 Bar (1000 PSI)	50 Bar (725 PSI)
	Max Flow	8.3 LPM (2.2 GPM)	16.3 LPM (4.3 GPM)	9.7 LPM (5.2 GPM)	26.9 LPM (7.1 GPM)	46.2 LPM (12.2 GPM)	69.6 LPM (18.4 GPM)	121 LPM (32 GPM)
E80	Max ΔP Per Land	100 Bar (1500 PSI)	100 Bar (1500 PSI)	60 Bar (850 PSI)	70 Bar (1000 PSI)	52 Bar (750 PSI)	70 Bar (1000 PSI)	50 Bar (725 PSI)
	Max Flow	8.3 LPM (2.2 GPM)	16.3 LPM (4.3 GPM)	9.7 LPM (5.2 GPM)	26.9 LPM (7.1 GPM)	46.2 LPM (12.2 GPM)	69.6 LPM (18.4 GPM)	121 LPM (32 GPM)

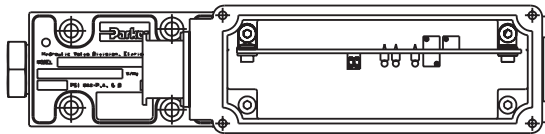
Valve Type

Series D*FH and D*FM

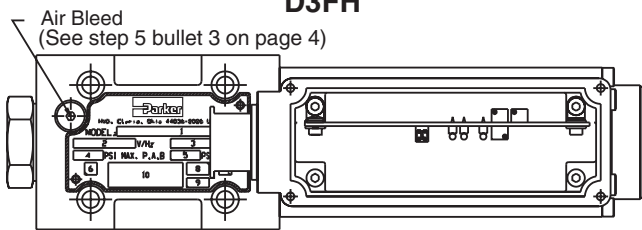
This valve operates using a 24 VDC supply, accepts a \pm voltage or current command, and interfaces to the system through a 7 pin I/O connector located on the conduit box.

This view has cover removed.

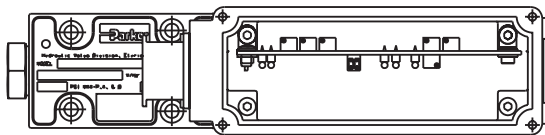
D1FH



D3FH



D1FM



D3FM

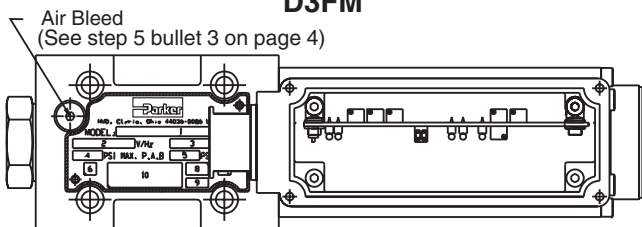


Figure 1 – Configurations

Installation

Refer to the back of the manual for fluid recommendations, mounting restrictions and other general installation instructions.

Refer to Catalog HY14-2550/US for the performance curves and valve dimensions for the D*FH and D*FM.

Power Supply	24 VDC Nominal 2.0 Amps 4.0 Amps Peak (<10 ms) + to Pin A - to Pin B
Enable	10 to 30 VDC at Pin C. The purpose of the enable is to center the spool for the single solenoid valve when energized. It provides a time delay for electronics stabilization on power up. When disabled or with loss of power, the valve returns to a defined position. This input is not meant to be part of normal cycle operation.
Command Input	± 10 VDC between Pin D and Pin E OR ± 20 mA with JP1 inserted. If D is more positive than E, flow is from P→A. Note: If command source is not differential, tie the unused input to the command source common.
Spool Position Output (connection optional)	± 10 VDC at Pin F Positive voltage is P→A. Negative voltage is P→B. -11.5V when disabled
Chassis Ground	Pin G internally wired to the valve body.

EHC158GE Cable Wiring

PIN	FUNCTION	COLOR
A	+Pwr Sup	Red
B	Pwr Sup Com	Black
C	Enable	Red/Black
D	+Cmd	Blue
E	-Cmd	Orange
F	Spool	White
G	Chassis Gnd	Green

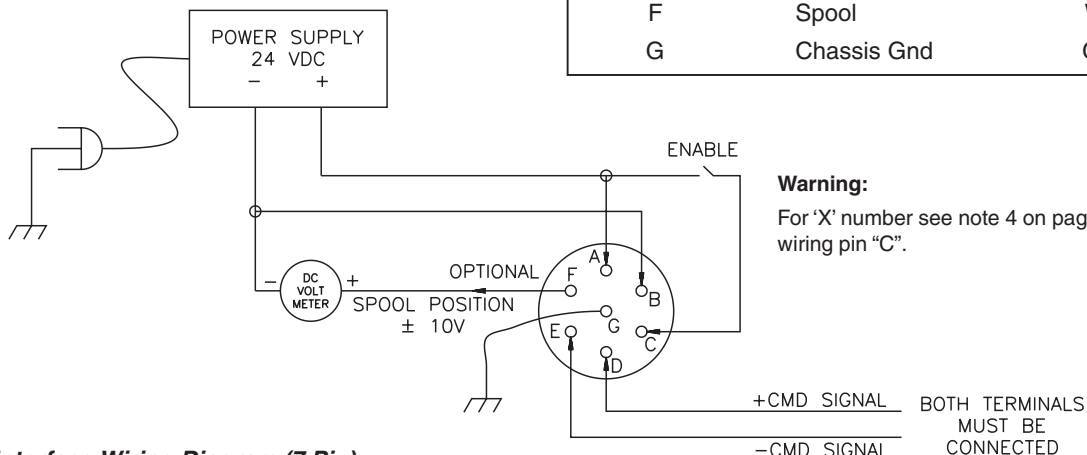


Figure 2 – Interface Wiring Diagram (7 Pin)

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Series D*FH

The following procedure is suggested for start up only. Once the valve is in the system and operating, this will not be required.

- 1) Thoroughly flush system by using lever operated directional control in place of the proportional valve.
- 2) Mount valve, keeping contamination to a minimum. We suggest you install a 1.4 Bar (20 PSI) check valve in the T port line. (Solenoid up not recommended)
- 3) Always start with the system gain at minimum — this is the external closed loop gain of your computer or PLC. If the system gain is too high, the valve will oscillate and could pull in air.
- 4) Apply DC power and 0V command. Enable the valve, followed by hydraulics. The enable signal has 10 ms (D1FH) or 30-50 ms (D3FH) time delay to allow the electronics to stabilize. During the transition with a 0V or 0mA command signal, the valve will go through the P→B, A→T position while traveling to the functional center position of the valve. Then allow the valve to warm up to oil temperature – approximately 5 minutes.

5) If the valve oscillates:

- Verify the system closed loop gain is at minimum.
- If possible in the application, cycle open loop or simply remove the command signal and short pins D & E together.
- For NG10 (D05) size valves, turn off hydraulic pressure, remove the air bleed plug, fill the chamber with oil and reinstall the plug.
- Refer to Troubleshooting section.

6) Run valve through a series of repeat cycles, in and out for 5 minutes to tune your controller gain. Adjust the system gain as required for system performance. If the response is better in one direction, for extend and retract, it probably means different gains need to be set in your controller for extend and retract.

Jumpers

Jumper Selection	Command Input
JP1 IN	+/- 20 mA Command Input
JP1 OUT	+/- 10 VDC Command Input
JP2 OUT	Factory setup only, do not insert

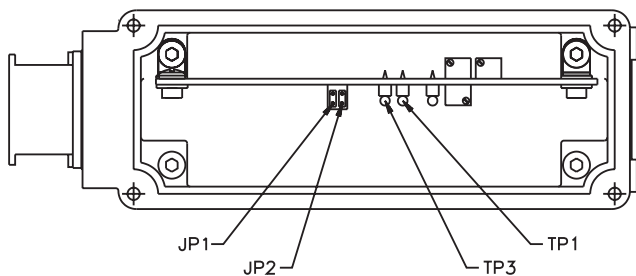


Figure 3 – Board Setup

Test Points

TP1	Spool Position
TP3	Common

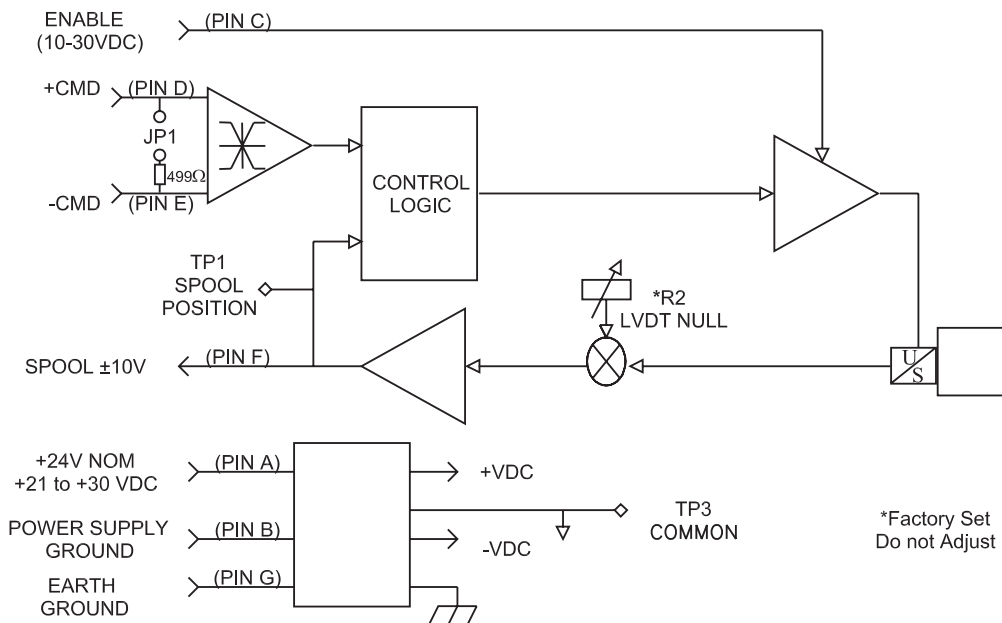
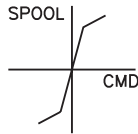


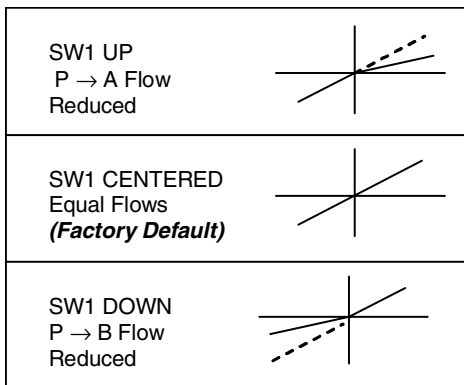
Figure 4 – Functional Block Diagram

Series D*FM

- 1) Perform steps 1-6 on page 4.
- 2) The flow will be linear with command position; however, the spool position will not be linear with command.



- 3) Cylinder Ratio Adjustment (R3) – flow versus command can be reduced in one direction to compensate for cylinder area ratio (up to 2:1).



Jumpers

Jumper Selection	Command Input
JP1 IN	+/- 20 mA Command Input
JP1 OUT	+/- 10 VDC Command Input
JP2 OUT	Factory setup only, do not insert

Test Points

TP1	Spool Position
TP3	Common

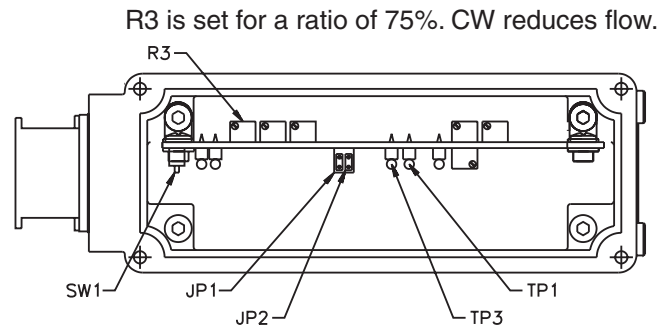


Figure 5 – Board Setup

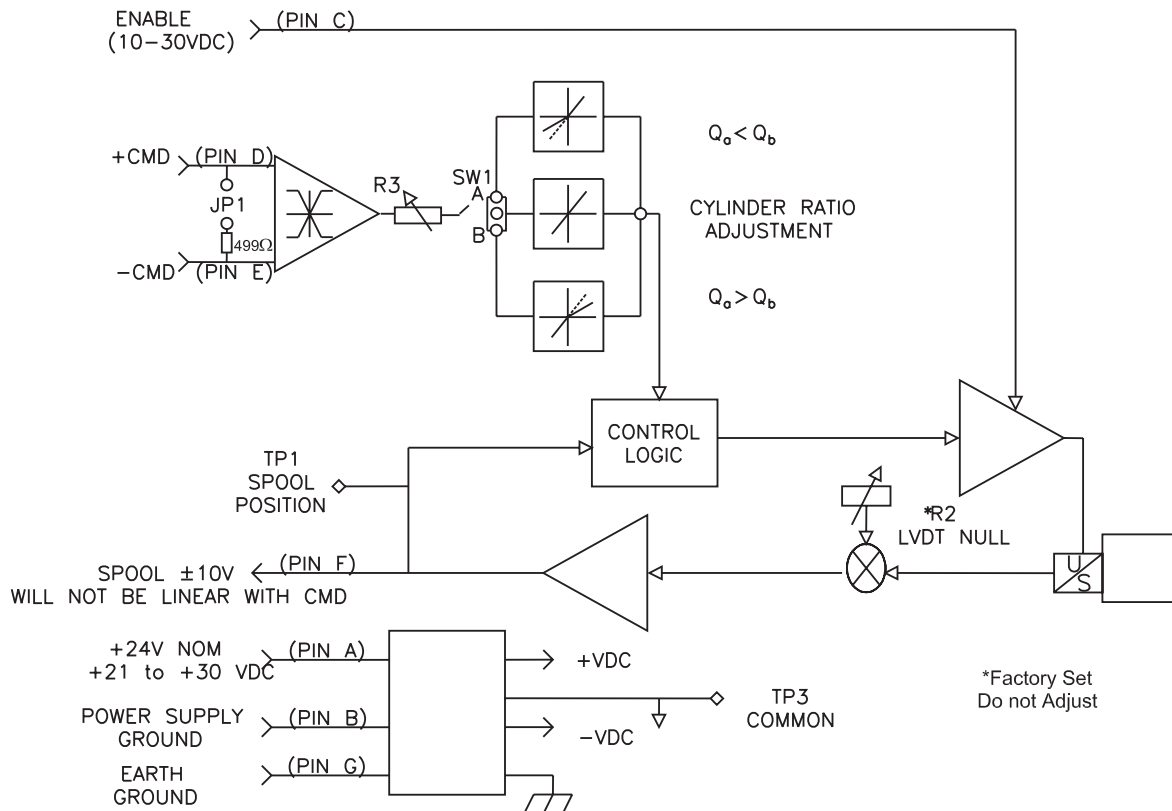


Figure 6 – Functional Block Diagram

Symptom	Cause	Solution
Instability	<i>Power Supply?</i>	Select a power supply not current limited below 4.0 Amps. Use a separate power supply for each valve. The power supply must be chassis grounded.
	<i>Noise on inputs?</i>	To verify, remove input signals and short +CMD to -CMD. The command inputs (Pins D & E) should never “float” or be left unconnected. There may not be problems with a one wire command referenced to common, but for best noise immunity, connect the differential input signals directly to the command source. This is a high bandwidth valve so 60 Hz noise at the inputs could be amplified.
	<i>System Gain?</i>	Initial startup should be with the external feedback loop gain at a minimum value and lower pressure. Oscillation may be a result of high loop gain. (Note: with motion controllers minimum gain may be less than one).
	<i>Oil Temperature?</i>	The oil temperature should be within the 38°C to 60°C (100°F to 140°F) range. (Viscosity range = 17 to 65 cSt or 75 to 300 SSU).
	<i>Air in valve?</i>	High frequency operation with low tank line pressure could result in air in the valve. The suggested tank line pressure is a minimum of 20PSI. To eliminate air, apply a low pressure and cycle the valve at a low frequency with a command of approximately ±10 VDC (or ±20 mA).
	<i>Air Bleed?</i>	For NG10 (D05) size valves, turn off hydraulic pressure, remove the air bleed plug, fill the chamber with oil, and reinstall the plug.
Null	<i>System Variations?</i>	The valve was nulled for a double rod cylinder. The external closed loop system gain compensates for load variations and provides the error signal required for null. With closed loop control removed, the actuator will drift. Circuit may require a fault effect mode manifold. For optimum performance the null should NOT be adjusted.
Low Flow	<i>Floating Input?</i>	Both input terminals must be connected. If only one terminal is used, tie the other terminal to command source common. System pressure? Verify that the system pressure is set as required and there are no other flow paths.
No Flow	<i>Power?</i>	Verify there is power to the valve wired with the correct polarity. Verify that the ENABLE signal is present. If the ENABLE signal is powered up by an external power source, common MUST be referenced to valve common. Verify that the connections to the valve subplate are correct.
Full Flow	<i>Phasing?</i>	If connected to an external feedback system, verify open loop operation of valve with a potentiometer. Improper system phasing would result in maximum command input to the valve.
Cylinder Extended/ Retracted and Won't Return	<i>Phasing?</i>	System phasing is incorrect. Try reversing the valve cmd and fdbk inputs.
Flow With No Enable	<i>System Dynamics?</i>	The spool will return to the fourth position only if the system dynamic flows and pressures are within the power capacity envelope. The fourth position is subject to all Bernoulli flow forces, radial hydraulic lock forces and other forces that affect all directional control valves. The system designer must determine if the dynamic flows and pressures in the system will prevent the spool from returning to the fourth position. This would have to be verified with full load testing. (Refer to Maximum Flow and Pressure Differential table on page 2) As with any blocked center four-way spool valve, the user should not rely on the valve to hold loads in place. The leakage rate through the fourth position blocked center spool (80 spool) will allow an unloaded single rod cylinder to extend.

**FOR MAXIMUM VALVE RELIABILITY,
ADHERE TO THE FOLLOWING
INSTALLATION INFORMATION**

Fluid Recommendations

Premium quality hydraulic oil with a viscosity range between 32-54 cSt (150-250 SSU) at 38°C (100°F) is recommended. The absolute operation viscosity range is from 17-65 cSt (75-300 SSU). Oil should have maximum anti-wear properties and rust and oxidation treatment.

Filtration

For maximum valve and system component life, the system should be protected from contamination at a level not to exceed 125 particles greater than 10 microns per milliliter of fluid. (ISO Code 16/14/11.)

Flushing the system prior to valve installation is recommended on new installations. (For Best Performance system should be cleaned to ISO Class 15/12/10 before installing valve)

Silting

Silting can cause any sliding spool valve to stick, and not spring return, if held shifted under pressure for long periods of time. The valve should be cycled periodically to prevent sticking.

Special Installations

Consult your Parker representative for any application requiring the following:

- Pressure above rated.
- Fluid other than those specified.
- Synthetic or fire-resistant fluids.
- Oil temperature above 71.1°C (160°F).
- Flow path other than normal.
- Non-standard power supply grounding.

System Design Consideration

The spool travels through P→B during enable to center position or disable to fourth position. Pressure spikes at port B must be taken into consideration during the design process.

Torque Specifications

The recommended torque values are for the bolts which mount the valve to the manifold or subplate are as follows:

NFPA Size	Bolt Thread Size		Torque
	Metric	English	
D03	M5 x 30	10-24 x 1.25"	5.6 N.m. (4.6 ft.-lbs or 50 in.-lbs)
D05	M6 x 40	1/4-20 x 1.625"	16.1 N.m. (12 ft.-lbs or 144 in.-lbs)
Air Bleed (D05)	–	5/16-24	3.9 N.m. (2.9 ft.-lbs or 35 in.-lbs)

Mounting Restriction

In order to ensure proper operation, the D*FH and D*FM must be mounted horizontally. A check valve with a minimum rating of 1.4 Bar (20 PSI) should be placed in the tank line to maintain back pressure to the valve.

Tank Line Surges

If several valves are piped with a common tank line, flow surges in the line may cause an unexpected spool shift. Separate tank lines should be used when line surges are expected.

Subplate Specifications

Subplate	Port Size	Location	Maximum Pressure
D1FH and D1FM (NG6/CETOP 3)			
SPD23SAS35	#6 SAE	Side	345 Bar (5,000 PSI)
SPD26SAS35	#12 SAE	Side	345 Bar (5,000 PSI)
D3FH and D3FM (NG10/CETOP 5)			
SPD3H6SAS35	#12 SAE	Side	345 Bar (5,000 PSI)

**EG - KONFORMITÄTSERKLÄRUNG
DECLARATION OF CONFORMITY
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Bezeichnung
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**Proportionalventil
Proportional valve
Valve proportionnelle**

Type, Modell
Type, Model
Type, Modèle

**D1FH Konstruktionsstand >12
D1FH Design series >12
D1FH Version de developpement >12**

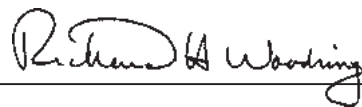
mit den Anforderungen der Normen
fullfils the requirements of the standards
satisfait aux exigences des normes

EN 50081-1	1994
EN 55011	
EN 50082-2	1996
ENV 50140	
ENV 50204	
EN 61000-4-2	
EN 61000-4-4	
EN 61000-4-5	
EN 61000-4-6	

übereinstimmt und damit den Bestimmungen der EG-Richtlinie 89/336/EG entspricht.
and therefore corresponds to the regulations of the EU-Directive 89/336/EEC.
et, ainsi, correspond aux reglement de la Directive du Conseil 89/336/CCE.

Parker Hannifin Corporation

Elyria, July 7, 1997

ppa. 
Name und Unterschrift des Befugten
Name and Signature of authorized Person
Nom et signature de la personne autorisée

Ort und Datum der Ausstellung
Place and Date of Issue
Lieu et date d'établissement

Diese Erklärung entspricht EN45014
This Declaration corresponds to EN45014
Cette Declaration correspond á EN45014

Installation Guide for Valves with On-Board Electronics for Compliance to Electromagnetic Compatibility Directive

Power Supply

The power supply used with the valve must also comply with the EMC standards (CE mark and certificate of conformity). Parker offers the PS24 (24 VDC, 4.5 Amps).

Do not connect inductive loads such as relays and solenoids to the valve power supply. If it is necessary to use a common power supply, suppression diodes must be added to limit inductive voltage spikes.

Wiring Cable

The wiring cable from a control cabinet to the valve must be a shielded braided cable. Suggested cable is an 20 awg.-19/30 stranded shielded cable - 1000 Volt Mil-W-16878D Type C conductor. The capacitance between wires should not exceed 130 pF/m and the maximum cable length is 50 meters. The cable should not be located in parallel with main power cables. The cable shield is to be connected to earth ground at both the control cabinet and to the 7 pin connector of the valve. However, be aware of ground loops depending on how the rest of the system is connected to earth ground.

Connectors

The connector on the the valve is a 7 pin metal connector with the center pin for earth ground. The connector gasket is metallic to allow for magnetic shielding. The mating connector must also be metal to meet the EMC requirements. Parker supplies the mating connector separately. PN 5004072.

Parker also supplies a cable assembly with the EMC required components. Parker part number EHC**8GE.

Note: The E stands for the EMC cable. The previously used EHC**8G cable assembly is a plastic connector and does not meet the EMC requirements.

Grounding

The mounting plate of the valve should be connected to the grounded metal machine frame. The earth ground wire of the 7 pin cable as well as the cable shield should be tied to Earth ground at the control cabinet. A low-ohmic potential compensation wire should be connected between the control cabinet and the machine frame (cable wire should be 7 awg. or lower) to prevent ground loops.

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2. Payment: Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Amounts not timely paid shall bear interest at the maximum rate permitted by law for each month or portion thereof that the Buyer is late in making payment. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer's receipt of the shipment.

3. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of shipment from Parker Hannifin Corporation. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED. NOTWITHSTANDING THE FOREGOING, THERE ARE NO WARRANTIES WHATSOEVER ON ITEMS BUILT OR ACQUIRED WHOLLY OR PARTIALLY, TO BUYER'S DESIGNS OR SPECIFICATIONS.**

5. Limitation Of Remedy: SELLER'S LIABILITY ARISING FROM OR IN ANY WAY CONNECTED WITH THE ITEMS SOLD OR THIS CONTRACT SHALL BE LIMITED EXCLUSIVELY TO REPAIR OR REPLACEMENT OF THE ITEMS SOLD OR REFUND OF THE PURCHASE PRICE PAID BY BUYER, AT SELLER'S SOLE OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY KIND OR NATURE WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS ARISING FROM OR IN ANY WAY CONNECTED WITH THIS AGREEMENT OR ITEMS SOLD HEREUNDER, WHETHER ALLEGED TO ARISE FROM BREACH OF CONTRACT, EXPRESS OR IMPLIED WARRANTY, OR IN TORT, INCLUDING WITHOUT LIMITATION, NEGLIGENCE, FAILURE TO WARN OR STRICT LIABILITY.

6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges

paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. Patents, U.S. Trademarks, copyrights, trade dress and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

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