

Flow Dividers Application and Selection Notes

Overview

When designing a circuit that requires division of pump flow into two independent branches, a flow divider/combiner valve does the trick. Divider/combiner valves provide pressure-compensated, proportional division of inlet flow, and also work bi-directionally to combine two flows.

HydraForce offers two flow divider/combiner valves in a range of sizes. Spool selection allows you to create varied ratios.

Style	10 Size	12 Size	16 Size
-44 style	FD50-44		
-45 style	FD50-45	FD52-45	FD56-45

The FD50-44 flow divider is very accurate within the defined flow range. This 10-size valve is the best choice when splitting flows below 12 lpm (3 gpm). The design features independent metering spools and a movable sleeve.

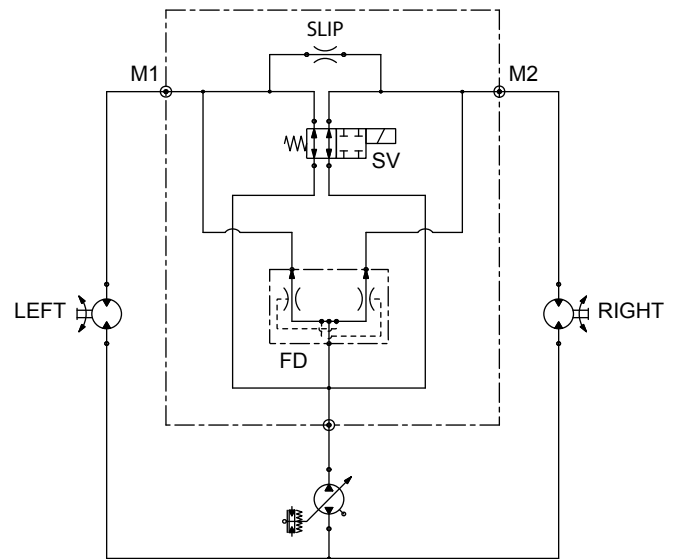
FD5x-45 style valves have slightly lower accuracy in most applications when compared to FD50-44. They also allow a synchronizing flow when one path stalls. This is limited to 10% of the rated inlet flow.

Application Considerations

Propel Applications

- Flow divider/combiner valves are bidirectional making them ideal for forward/reverse flows in parallel drive circuits. The flow divider/combiner keeps all wheels turning regardless of load or traction conditions.
- Unequal divisions are possible when front/rear drive motors or wheels may be of different sizes. See division tables for spool selection.
- Parallel drive circuits may require a cross-port orifice to allow additional flow through the outside motor when the vehicle is cornering. Schemes that sense steering angle and use proportional valving can control this differential flow path very precisely.

- Using a solenoid valve to bypass the flow divider creates two driving modes: normal and diff-lock or posi-traction mode.
- Fluid viscosity and temperature are critical factors to propel system performance. Consider pressure drop through the flow dividers and associated heat generation when calculating cooling requirements.



Typical two-wheel parallel drive circuit with differential lock

For detailed information and specifications, visit www.hydraforce.com or contact your local HydraForce representative at www.hydraforce.com/distributors/world.htm

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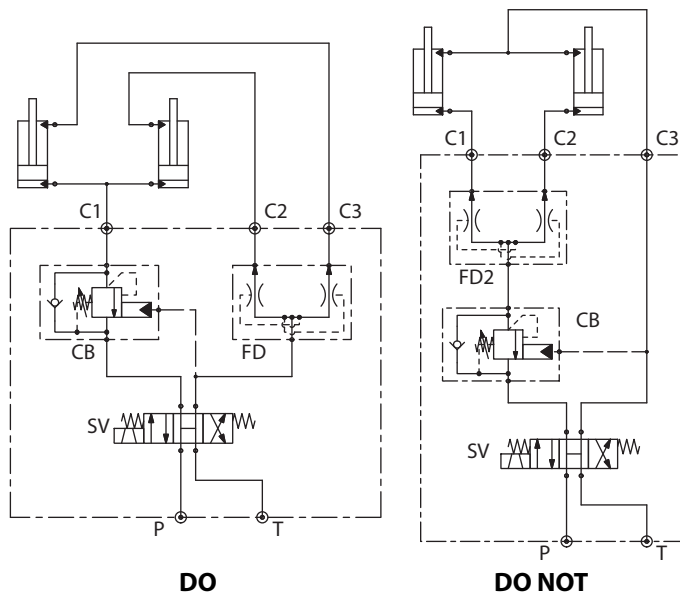
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Multiple Cylinder Applications

- Flow divider/combiner valves can accurately divide flow to multiple cylinders that operate different parts of a device in unison.
- Given the product's stated accuracy, it is important to consider that differences in flow will favor the circuit leg with higher load in combining mode and lower load in dividing mode. If a rigid frame connects two cylinders, the lagging cylinder may cavitate.
- The FD5x-45 valve will allow a small flow (typically 10% of rated inlet flow) to synchronize cylinders if one reaches end of stroke before the other.
- Flow divider/combiner valves operate when there is flow to divide. They are spool valves and will not hold a load. Consider poppet style, load-holding check, or counterbalance valves as needed.
- In some applications, placing two meter-out devices in series can cause problems. Consider placing the flow divider/combiner and counterbalance valve on opposite sides of the cylinder..



Parallel cylinders with flow divider/combiner. Applications that require load-holding may require separate counterbalance valves on each cylinder.

Product Selection

Two styles of flow divider/combiner valves are available: the FD50-44 and the FD5x-45. Both styles perform similarly. There is some overlap in flow ranges of the 10-size cartridges, however the -44 style has a higher accuracy at low flow rates.

Accuracy

Model	Accuracy
FD50-44-0-N-11/22/44	5% of inlet flow at maximum flow, 10% at minimum flow
FD5x-45-0-N-22/33/44/55/66	10% of inlet flow
FD5x-45-0-N-88/99	15% of inlet flow
FD56-45-0-N-44/66/88/99	10% (from 25%-100% of rated flow)
Asymmetrical spool combinations	Undefined. Ensure appropriate application testing for suitability.

Sizing Considerations

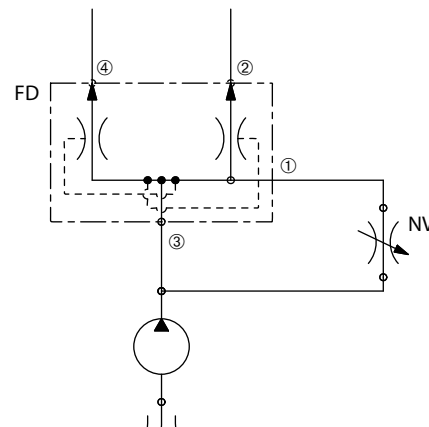
- See flow range options in the catalog for spool selection.
- Divider/combiner valve accuracy generally improves with higher pressure drop.
- A good rule of thumb is to size for about 7 to 14 bar (100 to 200 psi) pressure drop at the required flow. Consult pressure drop curves.
- To conserve energy, size for the lowest pressure drop that provides acceptable accuracy for your application.
- For flows below 2 lpm (0.5 gpm), use FD50-44-0-N-11.
- For high accuracy applications from 2 to 11 lpm (0.5 to 3 gpm), use FD50-44-0-N-22.
- Exceeding flow limits of FD5x-45 can damage the valve.

Flow Division

Two spools accomplish flow division/combination through the valve, each controlling one leg of the circuit. The trailing two digits of the order code define spool selection. Spools are rated for different flows based on the size of the flow passages. Accuracy diminishes with lower pressure drop, therefore choose spools that match your flow requirements.

Mixing spools, it is possible to contrive flow dividers of unequal ratios. See *Dividing/Combining Ratio Tables* for possible combinations and flow ratings.

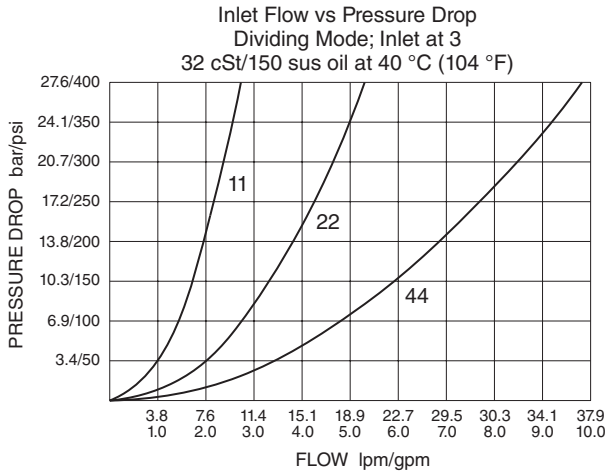
A blocked spool (option 0) is available as an option for creating a variable divider network using a needle valve. Flow from the needle valve enters the flow divider at port 1.



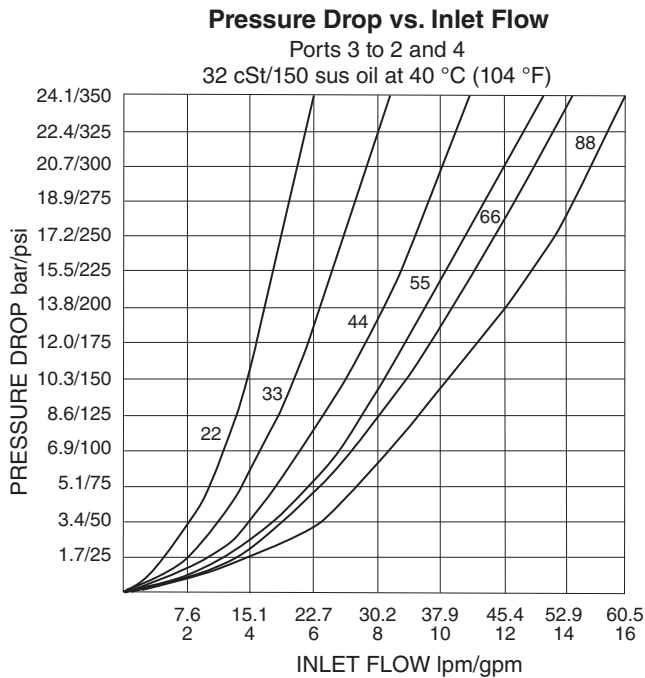
Adjustable flow divider: Connect needle valve between ports 3 and 1 to vary spool orifice and dividing ratio. This is the function of the 0-spool.

Pressure Drop Curves

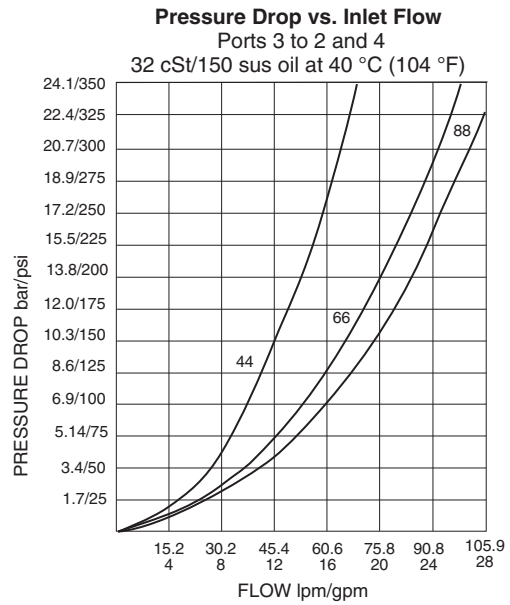
FD50-44



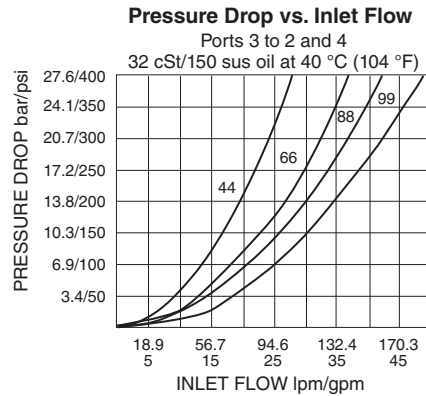
FD50-45



FD52-45



FD56-45



Model Code

FD 5A - BB - CCC - D - EE

A Size

- 0 10-Size
- 2 12-Size
- 6 16-Size

BB Design/Logic

- 44.....-44 Style
- 45.....-45 Style

CCC Body and Ports

- 0 Cartridge only
- See catalog page for port and body options

D Seals

- N Buna N (std.)
- V Fluorocarbon
- P Polyurethane (U/P req. for 245 bar/5000 psi)
- U Urethane (U/P req. for 245 bar/5000 psi)

EE Dividing/Combining Ratio

See tables

Dividing/Combining Ratio Tables

FD50-44

Spool 1	Spool 2	Port 2 flow	Port 4 flow	Rated inlet flow
4	4	50%	50%	38 lpm (10 gpm)
	3	43%	57%	33 lpm (8.75 gpm)
	2	33%	67%	28 lpm (7.5 gpm)
	1	20%	80%	24 lpm (6.25 gpm)
	0	0-100%	0-100%	19 lpm (5 gpm)
3	2	40%	60%	24 lpm (6.25 gpm)
	1	25%	75%	19 lpm (5 gpm)
	0	0-100%	0-100%	14 lpm (3.75 gpm)
2	2	50%	50%	19 lpm (5 gpm)
	1	33%	67%	14 lpm (3.75 gpm)
	0	0-100%	0-100%	9 lpm (2.5 gpm)
1	1	50%	50%	9.5 lpm (2.5 gpm)

FD50-45

Spool 1	Spool 2	Port 2 flow	Port 4 flow	Rated inlet flow
8	8	50%	50%	57 lpm (15 gpm)
	6	43%	57%	51 lpm (13.5 gpm)
	5	38%	62%	49 lpm (13 gpm)
	4	33%	67%	47 lpm (12.5 gpm)
	3	27%	73%	42 lpm (11 gpm)
	2	20%	80%	38 lpm (10 gpm)
	0	0-100%	0-100%	28 lpm (7.5gpm)
6	6	50%	50%	45 lpm (12 gpm)
	5	45%	55%	44 lpm (11.5 gpm)
	4	40%	60%	42 lpm (11 gpm)
	3	37%	63%	36 lpm (9.5 gpm)
	2	25%	75%	32 lpm (8.5 gpm)
	0	0-100%	0-100%	23 lpm (6 gpm)

Spool 1	Spool 2	Port 2 flow	Port 4 flow	Rated inlet flow
5	5	50%	50%	42 lpm (11 gpm)
	4	44%	56%	40 lpm (10.5 gpm)
	3	38%	62%	34 lpm (9 gpm)
	2	29%	71%	30 lpm (8 gpm)
	0	0-100%	0-100%	21 lpm (5.5 gpm)
4	4	50%	50%	38 lpm (10 gpm)
	3	43%	57%	32 lpm (8.5 gpm)
	2	33%	67%	28 lpm (7.5 gpm)
	0	0-100%	0-100%	19 lpm (5 gpm)
3	3	50%	50%	27 lpm (7 gpm)
	2	40%	60%	23 lpm (6 gpm)
	0	0-100%	0-100%	13 lpm (3.5 gpm)
2	2	50%	50%	19 lpm (5 gpm)

FD52-45

Spool 1	Spool 2	Port 2 flow	Port 4 flow	Rated inlet flow
8	8	50%	50%	106 lpm (28 gpm)
	6	43%	57%	98 lpm (26 gpm)
	5	38%	62%	91 lpm (24 gpm)
	4	33%	67%	83 lpm (22 gpm)
	3	27%	73%	76 lpm (20 gpm)
	2	20%	80%	72 lpm (19 gpm)
	0	0-100%	0-100%	53 lpm (14 gpm)
6	6	50%	50%	91 lpm (24 gpm)
	5	45%	55%	83 lpm (22 gpm)
	4	40%	60%	76 lpm (20 gpm)
	3	33%	67%	72 lpm (19 gpm)
	2	25%	75%	64 lpm (17 gpm)
	0	0-100%	0-100%	45 lpm (12 gpm)
5	4	44%	56%	68 lpm (18 gpm)
	3	38%	62%	64 lpm (17 gpm)
	2	29%	71%	57 lpm (15 gpm)
	0	0-100%	0-100%	38 lpm (10 gpm)
4	4	50%	50%	61 lpm (16 gpm)
	3	43%	57%	57 lpm (15 gpm)
	2	33%	67%	49 lpm (13 gpm)
	0	0-100%	0-100%	30 lpm (8 gpm)
3	2	40%	60%	45 lpm (12 gpm)
	0	0-100%	0-100%	26 lpm (7 gpm)

FD56-45

Spool 1	Spool 2	Port 2 flow	Port 4 flow	Rated inlet flow
9	9	50%	50%	197 lpm (52 gpm)
	8	43%	57%	182 lpm (48 gpm)
	7	39%	61%	172 lpm (45.5 gpm)
	6	36%	64%	163 lpm (43 gpm)
	5	32%	68%	155 lpm (41 gpm)
	4	27%	73%	148 lpm (39 gpm)
	3	22%	78%	134 lpm (35.5 gpm)
	2	16%	84%	121 lpm (32 gpm)
	0	0-100%	0-100%	98 lpm (26 gpm)
8	8	50%	50%	167 lpm (44 gpm)
	7	47%	53%	157 lpm (41.5 gpm)
	6	43%	57%	148 lpm (39 gpm)
	5	38%	62%	140 lpm (37 gpm)
	4	33%	67%	132 lpm (35 gpm)
	3	27%	73%	119 lpm (31.5 gpm)
	2	20%	80%	106 lpm (28 gpm)
	0	0-100%	0-100%	83 lpm (22 gpm)
7	6	46%	54%	138 lpm (36.5 gpm)
	5	42%	58%	131 lpm (34.5 gpm)
	4	36%	64%	123 lpm (32.5 gpm)
	3	30%	70%	110 lpm (29 gpm)
	2	22%	78%	98 lpm (26 gpm)
	0	0-100%	0-100%	74 lpm (19.5 gpm)
6	6	50%	50%	128 lpm (34 gpm)
	5	45%	55%	121 lpm (32 gpm)
	4	40%	60%	114 lpm (30 gpm)
	3	33%	67%	100 lpm (26.5 gpm)
	2	25%	75%	98 lpm (23.5 gpm)
	0	0-100%	0-100%	74 lpm (17 gpm)
5	4	44%	56%	106 lpm (28 gpm)
	3	38%	63%	93 lpm (24.5 gpm)
	2	29%	71%	81 lpm (21.5 gpm)
	0	0-100%	0-100%	57 lpm (15 gpm)
4	4	50%	50%	98 lpm (26 gpm)
	3	43%	57%	85 lpm (22.5 gp)
	2	33%	67%	72 lpm (19 gpm)
	0	0-100%	0-100%	49 lpm (13 gpm)
3	2	40%	60%	61 lpm (16 gpm)
	0	0-100%	0-100%	36 lpm (9.5 gpm)

Supersession

Three older variations (FDxx-40, 41, 42) of the flow divider/combiner are being phased out. For a number of years, HydraForce has recommended using the FD5x-44, 45 style valves for all new applications. The newer designs include these performance enhancements:

- Tighter spool-to-cage clearance reduces leakage.
- Washers and retaining rings replace pressed-in stops for ease of assembly.
- Floating cage design increases installation torque and pressure capacity.
- -44 style movable sleeve and independent spools perform better and increase durability.
- -45 style valves include stronger spool hooks to eliminate pressure limitations.
- Larger inlet ports increase flow performance.
- Modified spool timing eliminates lock-up in combining mode.
- Fits standard cavity – old design required a modified cavity to retain the end cap.

Converting from FDxx-40, 41, 42

- Exceeding maximum rated flow through the valve drastically increases pressure drop and may cause valve failure.
- Most applications will benefit from the better accuracy of the newer product. The main consideration when crossing over is the impact of reduced tolerance. For example: some drive circuits may have got by without cross-port flow path for turning differential. You will want to verify drive circuits have adequate differential flow.
- Multiple cylinder applications that had cross-port accommodation for sync-up may be accurate enough with the newer products to eliminate this. Loss of sync should be minor enough for spool leakage to accommodate sync up at end of stroke. Pressure compensation should perform well enough to address uneven loading.