Commercial Hydraulics	Description:	Model:
Manufacturing Locations: Sachsenhydraulik Gmbh Chemnitz, Germany Ultra Hydraulics Ltd, Cheltenham, United Kingdom	**Rotary Flow Dividers** **- Pressure Intensifiers**	**FD:** **31/51/76** **330/350/365**
	Brochure No.: 1/DS/1/ENG/RUD/1197	File Ref.: Data Sheets/FlowDiv.PM6

General Information

Commercial's flow dividers (intensifiers) are available in the 31, 51 and 76 roller bearing series, and the 330, 350 and 365 sleeve bushing series.

These units are made from standard hydraulic motor components.

Rotary flow dividers/pressure intensifiers offer advantages often overlooked when designing a hydraulic circuit. They are unique components which can be considered to "float" in the hydraulic circuit, working only when required, and then only to the extent necessary. Operating automatically, they do not require pilot signals or other devices to initiate their operation. Unlike variable orifice types, rotary flow dividers operate on the well-known principle:

Energy in = Energy out
minus a small efficiency loss

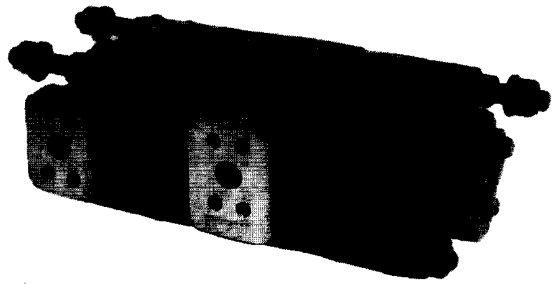
If the pressure at an outlet is lower than the inlet pressure, the low pressure section acts as a motor. The energy expended across the motor is not wasted generating heat but is applied through the connecting shaft to do work in the other section or sections.

Subcircuit pressure can be intensified above input pressure. Because of the flow divider's capacity to intensify pressure, the pump and all subcircuit outputs must have relief valve protection.

From the pump, only one supply line is normally needed since the inlet port feeds each section via internal passages. A maximum of 6 sections may be assembled in one block.

The 700 RPM minimum operating speed insures adequate efficiency to properly function. 1300 RPM is the recommended maximum speed. Excessive noise may occur above this level.

The FD 31/51/76 do not require an external drain. The FD 330/350/365 series however, must have a drain port in one port end cover to drain internal leakage from the bushing cavity, e.g. 3/8" ODT or $^{1}/_{4}$ BSPP. Four gear section or larger units will also require a second drain line placed in the other port end cover, or larger port machining in the original drain port.



Pressure Ratings

The 31/51/76 series can be used in systems at pressures up to 241 bar (3500 psi). The 330/350/365 versions can be used in systems pressurised to 275 bar (4000 psi).

Benefits

When properly applied, Commercial's flow dividers/ pressure intensifiers offer many advantages.

Performance advantages:

- The design and close manufacturing tolerances keep internal leakage to a minimum, ensuring a high degree of accuracy;
- Cast Iron construction;
- Flow dividers are pressure charged, eliminating problems common in feeding multiple pumps;
- FD 330/350/365 are perfectly suited for fire resistant fluids;
- Self lubricating and require no maintenance;
- Flow dividers can be mounted in any position;
- Extended studs for easy mounting;
- Increase in circuit versatility;
- Increased pump life;
- Convenience.

Applications

Typical applications are:

- Simplification of plumbing in complex circuits;
- Motor synchronisation on conveyors, propel systems etc.;
- Cylinder synchronisation on lift systems, grapples etc.

Ports

Standard porting of the FD 31, 51, 76 flow divider range is through the gear housing or bearing carrier. Porting through the port end covers is available on special request. For the FD 330, 350 and 365 range, porting is through the bearing carrier and port end. No porting is through the gear housing.

Two studs extend from each end of the flow divider for easy mounting.

When requesting port sizes, please use the Summary Chart shown on page 9 (table 8).

Performance Data

Flow dividers operate most efficiently with gear codes 10 or larger, and at speeds from 700 to 1300 rpm. *(For gear coding, please see page 6, table 5)*.Therefore, when sizing a flow divider, it is important to keep these two points in mind. As a general rule, flow dividers are rated so that the maximum pressure differential is identical to the pressure rating of the same unit when it is a pump or motor. The maximum inlet pressure (or outlet pressure if intensification is present) for the FD31, 51 & 76 series is 241 bar (3500 psi) and for the FD300 units, it is 276 bar (4000 psi) - as long as the maximum differential pressure is not exceeded. Outside these limits, applications should be referred to the Technical Services Department.

One other point to consider is the choice of gear widths as these dictate the flow split proportions. **Gear widths (see table 5) are directly proportional to displacement, for a given frame size. Gear codes are only a convenient abbrieviation.** Caution should be taken to ensure narrow gears (codes 05 and 07) are not used exclusively in an assembly. This is because the designed slip loss of a narrow gear width is a higher portion of its' total output flow. Narrow gear widths are also less efficient causing heat and unreliable flow split. They can however be used if the flow divider also contains larger gear widths.

Flow split accuracy is dependent on the pressure differential between the outputs of neighboring sections. For example: A FD50 flow divider is used to split a 190 litres flow into two output flows.

Performance Data cont/d...

If both of these flows are at the same pressure, then the flow split will be approximately 95 litres each.

However, if one flow is at maximum system pressure and the other is returning to tank with no pressure, then the pressurized flow could be as low at 76 litres, and the unpressurized flow could be as high as 114 litres.

Whenever possible, position the inlet port nearest the largest gear unit. Normally, the largest gear section should be in the centre of the unit.

Selecting the correct Flow Divider

The first step in choosing a flow divider model is to match the pressure requirement with the appropriate series. Any gear width providing the largest required flow within the speed range can be used as a starting point to create a flow divider.

For example:

Problem #1

- Flow split: 50%, 30%, and 20%;
- 250 litres pump supply;
- Subsystem pressures are: 150 bar (2200 psi), 100 bar (1450 psi) and 30 bar (400 psi) respectively;
- Subsystems will be pressurised simultaneously.

Flow split calculation:

50% of 250 litres	=	125 litres
30% of 250 litres	=	75 litres
20% of 250 litres	=	50 litres

Step 1: Select the correct Flow Divider series.
In this case, the maximum output pressure is 150 bar (2200 psi). The FD 31, 51 and 76 meet this requirement.

Step 2: Select gear width that matches the largest output flow requirement and falls into the correct speed range.

Selecting the correct Flow Divider cont/d...

Examine the flow charts (please refer to table 2, page 4). Two FD 51 gear widths closely match the 125 litres requirement: gear code 25 at 1200 RPM, and gear code 20 at 1500 RPM. Gear code 25 is within the recommended speed range, whilst gear code 20 exceeds this limit.

Step 3: Compare the smaller gear width flows at the same speeds.

Check to see if the smaller gear width flows correspond with the other requirements of the flow divider at the same speed. At 1200 RPM the gear code 15 has a flow of 75.2 litres and code 10 provides 50.2 litres. Both are very close to the required flows.

For this problem, the following Flow Divider configuration would be suitable:

FD51 ~ 25 ~ 15 ~ 10

Gear Codes

Will any other gear widths work?
Other choices of gear widths may be available when choosing a flow divider for specific applications. However, your final choice should depend on the ability to match the smaller flow requirements with other gear widths at the chosen speed.

In this example, two possible choices for the flow divider configuration were found. One used a code 25 gear set to provide the 125.4 litres flow, and the other used a code 20 to provide a flow of 125.4 litres also. On this occassion, the gear code 25 was chosen because it produced a flow split that more precisely matched the smaller flow requirements, and remained within the recommended speed range.

Using a Flow Divider for pressure intensification

Any rotary flow divider has the potential for pressure intensification.

Consider the following example of a pump supplying flow to a two section (equal gear width) flow divider. There is relief protection between the pump and flow divider but no relief at the output of either flow divider section.

Pressure intensification cont/d...

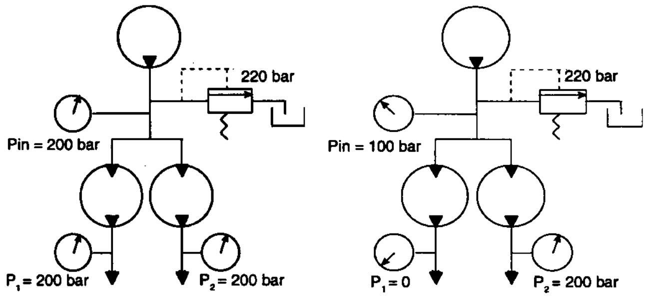


Figure 1 ***Figure 2***

Figure 1 shows both flow divider outputs pressurised to 200 bar. They may be driving motors, cylinders, etc. The input pressure is also 200 bar.

Figure 2 shows one flow divider section taken off load for whatever reason, but the second section is still working at 200 bar.

The input pressure has dropped to 100 bar because of the law of conservation of energy.

Problem #2
Using the above as an example, let us now calculate the maximum intensification pressure possible in this circuit. We now use the basic flow divider equation as follows:

$TGW \times TIP = (GW_1 \times OP_1) + (GW_2 \times OP_2)$ ...

TGW	=	Total Gear Width
TIP	=	Theoretical Input Pressure
GW_1	=	Gear width of the 1st section
OP_1	=	Operating pressure of the 1st section
GW_2	=	Gear width of the 2nd section
OP_2	=	Operating pressure of the 2nd section

This formula mathematically illustrates the principle of fluid horsepower conservation that is unique to rotary flow dividers.

In our example, G_1 and G_2 are equal (figure 1). The maximum TIP = 220 bar. If we assume $OP_2 = 0$, what is the maximum intensification pressure seen at OP_1?

$$2 \times 220 \text{ bar} = (1 \times OP_1) + (1 \times 0)$$

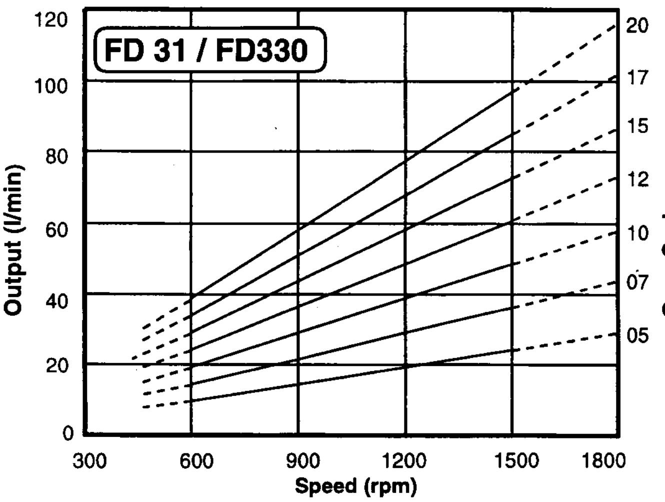
$$440 \text{ bar} = OP_1$$

These numbers were used for illustrative purposes only. The actual input pressure may be 7 - 15 bar higher than the theoretical values shown because of ineffeciencies.

Output Flow

Table 1 **FD31 / FD330**

Speed rpm	Gear Code										
	05	07	10	12	15	17	20	22	25	27	30
600	9.7	14.5	19.4	24.2	29.0	33.9	38.8	-	-	-	-
900	14.5	21.8	29.1	36.4	43.6	50.9	58.1	-	-	-	-
1200	19.3	29.0	38.8	48.5	58.1	67.8	77.5	-	-	-	-
1500	24.2	36.3	48.5	60.6	72.6	84.8	96.9	-	-	-	-
1800	29.0	43.6	58.1	72.7	87.1	101.7	116.3	-	-	-	-
2100	33.8	50.8	67.8	84.8	101.6	118.7	135.7	-	-	-	-



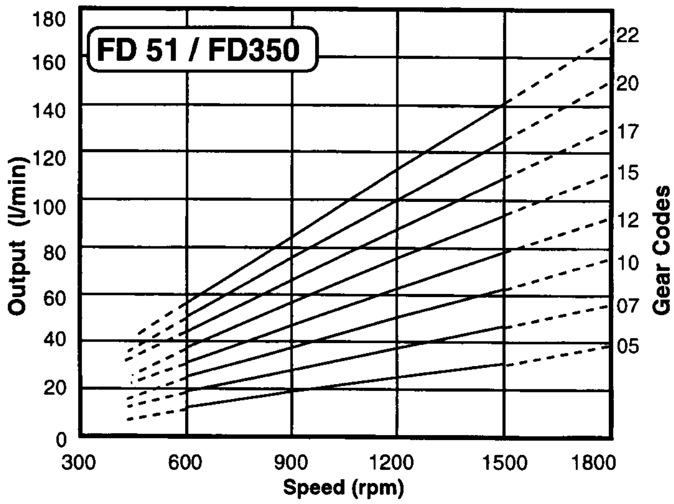


Table 2 **FD51 / FD350**

Speed rpm	Gear Code										
	05	07	10	12	15	17	20	22	25	27	30
600	12.5	18.8	25.1	31.3	37.6	43.9	50.2	56.4	62.7	-	-
900	18.8	28.2	37.6	47.0	56.4	65.8	75.2	84.6	94.1	-	-
1200	25.1	37.6	50.2	62.6	75.2	87.7	100.3	112.8	125.4	-	-
1500	31.4	47.0	62.7	78.3	94.1	109.7	125.4	141.0	156.8	-	-
1800	37.6	56.3	75.2	94.0	112.9	131.6	150.5	169.2	188.1	-	-
2100	43.9	65.7	87.8	109.6	131.7	153.5	175.6	197.4	219.5	-	-

Commercial Hydraulics

Manufacturing Locations:
Sachsenhydraulik Gmbh Chemnitz, Germany

Ultra Hydraulics Ltd, Cheltenham, United Kingdom

Description:

Rotary Flow Dividers - Pressure Intensifiers

Model:

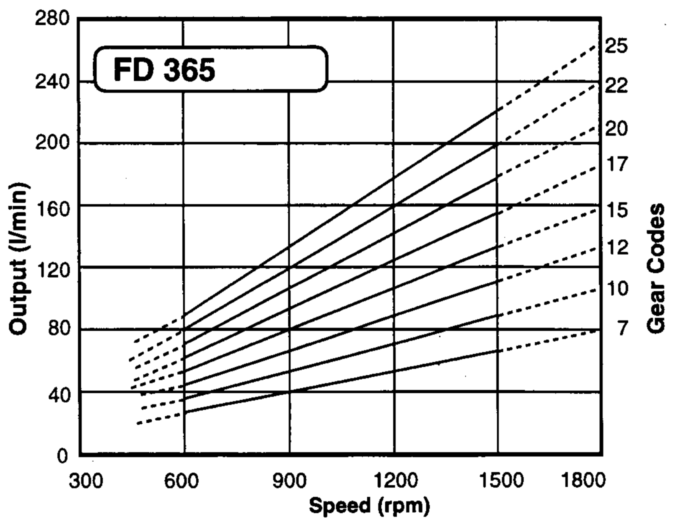
FD: 31/51/76 330/350/365

Brochure No.: 1/DS/1/ENG/RUD/1197 | File Ref.: Data Sheets/FlowDiv.PM6

Output Flow

Table 3 **FD365**

Speed rpm	Gear Code									
	05	07	10	12	15	17	20	22	25	27	30
600	-	26.6	35.4	44.3	53.1	62.0	70.8	79.7	88.5	-	-
900	-	39.9	53.1	66.4	79.7	93.0	106.2	119.5	132.8	-	-
1200	-	53.2	70.8	88.6	106.2	124.0	141.6	159.4	177.0	-	-
1500	-	66.5	88.5	110.7	132.8	155.0	177.0	199.2	221.3	-	-
1800	-	79.7	106.2	132.8	159.3	185.9	212.4	239.0	265.5	-	-
2100	-	93.0	123.9	155.0	185.9	216.9	247.8	278.9	309.8	-	-



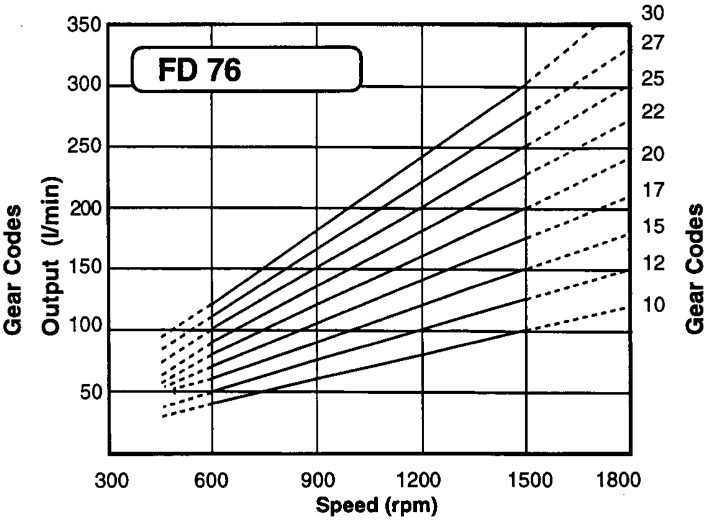


Table 4 **FD76**

Speed rpm	Gear Code									
	05	07	10	12	15	17	20	22	25	27	30
600	-	-	40.3	50.4	60.5	70.6	80.6	90.7	100.8	110.9	121.0
900	-	-	60.5	75.6	90.7	105.8	121.0	136.1	151.2	166.3	181.4
1200	-	-	80.6	100.8	121.0	141.1	161.3	181.4	201.6	221.8	241.9
1500	-	-	100.8	126.0	151.2	176.4	201.6	226.8	252.0	277.2	302.4
1800	-	-	121.0	151.2	181.4	211.7	241.9	272.2	302.4	332.6	362.9
2100	-	-	141.1	176.4	211.7	247.0	282.2	317.5	352.8	388.1	423.4

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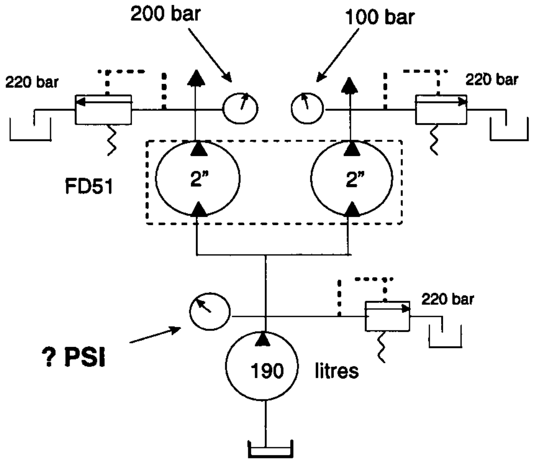
Using a Flow Divider for pressure intensification

Problem #3

A circuit has the following parameters:

- A 190 litres pump supply;
- Flow Divider (FD51B BYAD20-1 GAD20BY)
- 3 Relief valves all set at 220 bar;
- Flow Divider output pressure requirements of 35 bar and 150 bar respectively.

What is the theoretical input pressure (TIP)?



Step 1: Establish the total gear width (TGW). Total gear width in any flow divider is always the sum total of all the gear widths.

In this example, the flow divider (FD51B BYAD20-1 GAD20BY) has two sections, both with gear widths of 2" (gear codes 20). Therefore the Total Gear Width for this particular flow divider = 4.

Step 2: Calculate the Theoretical Input Pressure (TIP) using the following formula:

$$TIP = \frac{(GW_1 \times OP_1) + (GW_2 \times OP_2) + ...}{TGW}$$

Theoretical Input Pressure equals 2 x 100 bar, plus 2 x 200 bar all divided by 4.

$$TIP = \frac{(2 \times 100) + (2 \times 200)}{4}$$

TIP = 150 bar

Step 3: An inefficiency factor should be added to the TIP pressure in order to obtain actual input pressure. These are as follows:

FD31/330	=	14 bar
FD51/350	=	20 bar
FD76/365	=	30 bar

For this problem, Theoretical Input Pressure plus 20 bar equals Actual Input Pressure. 150 bar plus 20 bar equals 170 bar.

Dimensions

Table 5

Gear Width Code	05	07	10	12	15	17	20	22	25	27	30
Gear Width (Inches)	1/2"	3/4"	1"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"
Gear Width (MM)	12.7	19.1	25.4	31.8	38.1	44.5	50.8	57.2	63.5	69.9	76.2

Commercial Hydraulics	Description:	Model:
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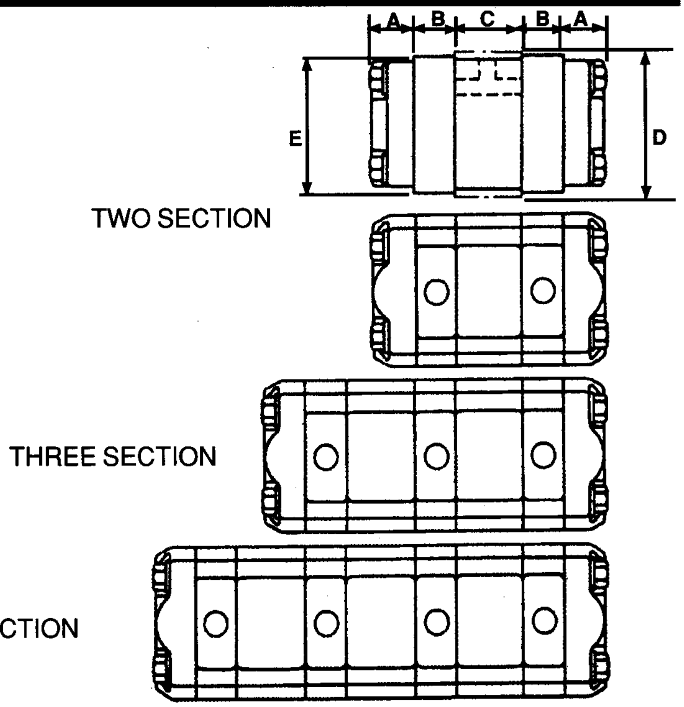
Dimensions — FD 31, 51, 76 Roller Bearing Series

Only overall dimensions are shown on this page. For specific dimensions on the various components of the FD 31, FD 51 and FD 76, excluding those of the bearing carriers shown on the next page, please see corresponding dimensions of the P30/31, P50/51 and P75/76 pumps detailed in catalogues H-60 and H-58.

Please consult our Technical Services Department when specifying split flange fittings. Because of the width of SAE split flange fittings, it may be necessary to code special gear housings and bearing carriers into the unit in order to install these fittings properly.



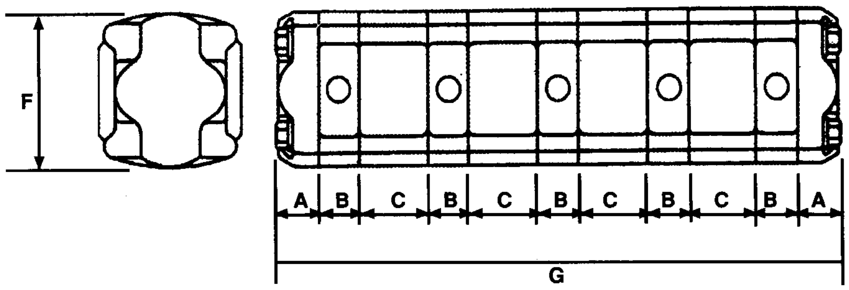
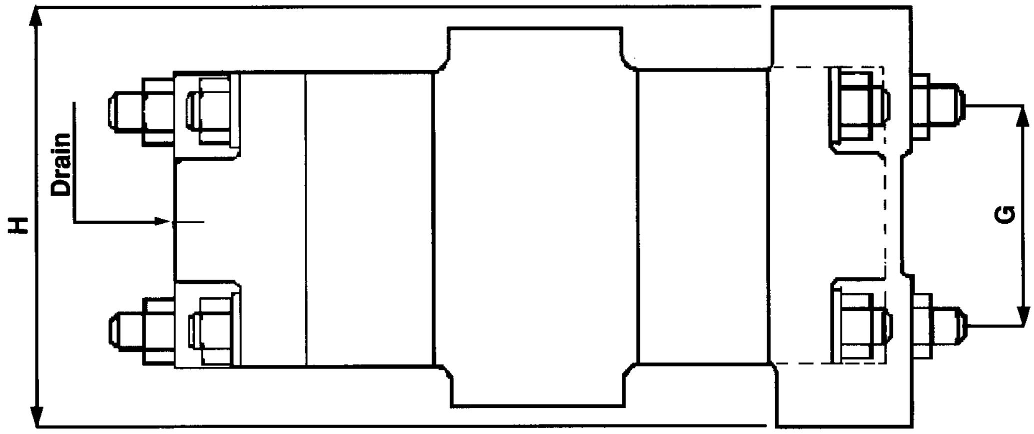


Table 6 All measurements in mm's.

Model	A	B	C	D	E	F	G Two Section	G Three Section	G Four Section	G Five Section
FD31	44.4	19.0 + GW	63.5	131.8 to 146.0	134.9 to 138.5	136.5	190.5 + GW	273.0 + GW	355.6 + GW	438.2 + GW
FD51	44.4	19.0 + GW	73.0	131.8 to 146.0	134.9 to 171.4	152.4	200.0 + GW	292.1 + GW	384.2 + GW	476.3 + GW
FD 76	50.8	25.4 + GW	76.2	187.3 to 200.0	190.5 to 193.7	200.0	228.6 + GW	330.2 + GW	431.8 + GW	533.4 + GW

Dimensions — FD 330, 350, 365 Sleeve Bushing Series



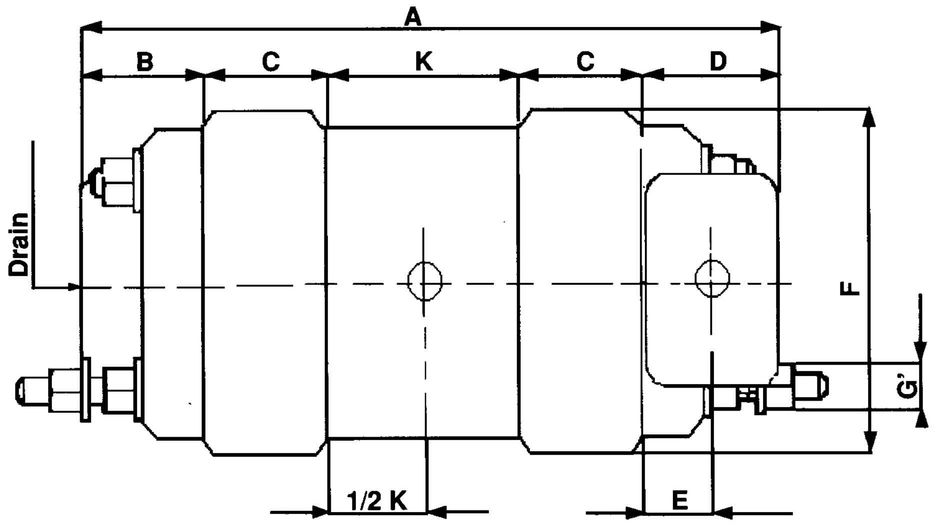


Table 7

All measurements in mm's.

	A	B	C	D	E	F	G	G'	H	K
FD 330	235 + GW	57	12.7 + GW	63.5	33.5	149.5	90.5	16	171.5	89
FD 350	257.5 + GW	57	12.7 + GW	86	39.5	152.5	90.5	16	181	89
FD 365	266.5 + GW	66.5	12.7 + GW	73	39.5	184	107.5	19	187.5	101.5

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	Brochure No.: 1/DS/1/ENG/RUD/97	File Ref.: Data Sheets/FlowDiv.PM6	

Definition of a flow divider - pressure intensifier

When specifying your flow divider/intensifier, please use the summary chart shown below. This will enable our Technical Services Department to provide you with the correct coding for the combination of your choice, quickly and efficiently.

An example of how to complete the form has also been given below. Should you have any queries please contact our Technical Services Department for assistance.

Table 8

EXAMPLE

Series	FD330	Codes	05	10	17	05		
Ports Type	BSPP							
Sizes Inlet	1 1/4"	Outlets	1/2"	1/2"	1"	1/2"		
Pressure *Please specify the Maximum Working Pressure requirement for each section.*			210	210	240	210		

SUMMARY

Series		Codes						
Ports Type								
Size Inlet		Outlets						
Pressure *Please specify the Maximum Working Pressure requirement for each section.*								