WEBTEC

WEBTEC PRODUCTS LIMITED

Hydraulic Components Catalogue

Manufacturers of hydraulic components and test equipment for the Mobile, Industrial and Agricultural industries

Hydraulic testing

Service - Development - Production

Handheld hydraulic dataloggers with USB connection

Precision turbine flowmeters with analog output

High pressure temperature sensors

Portable hydraulic testers

Flow, Temperature Measure, display, switch, transmit

Please contact sales for more information

WEBTEC
WEBTEC PRODUCTS LIMITED

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Contents

Introduction

Our mission

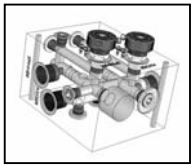
We are a manufacturing company making fluid power products for use on mobile and industrial machinery. It is our aim to design, develop and build new and innovative products to satisfy the requirements of our customers.

Quality - ISO 9001:2008

We are an accredited ISO 9001 company and are committed to a programme of "Total Quality".

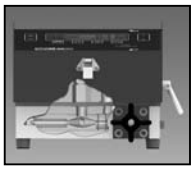
Research and development

We are constantly developing and improving our products and we are always happy to engineer custom versions of standard products as well as special valve solutions.



Multi-skilled

Through our development of hydraulic test equipment we have gained a wide range of in-house engineering skills.

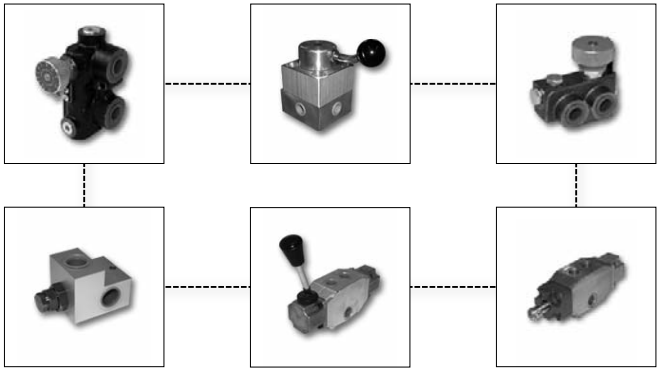


Manufacturing

We manufacture our products using precision CNC machine tools to ensure unparalleled accuracy and quality.

Hydraulic Components

Our range of hydraulic control valves are used on a large variety of mobile machinery. The range has evolved from traditional well-tested designs to include many custom features and specially designed flow, pressure and directional control valves.



Hydraulic Test Equipment

Our range includes over 350 different portable hydraulic testers, flowmeters, pressure transducers, temperature sensors, speed sensors, hydraulic data acquisition and digital display systems.

How to Order

For full Terms and Conditions please see the back page of the catalogue.

Placing Orders
We are very happy to receive orders by post, fax, email, telephone or verbally at the door. However, we do need an order number and written confirmation, without this we have found that on occasions it is sometimes difficult to get payment for goods. When appropriate, orders may be re-directed to your local distributor who acts on our behalf and may contact you directly.

We manufacture many different products and usually each has several options. Our ordering codes will be a definitive description of the product. If you can quote this it can save a lot of time. However, if you cannot determine this please let us know. It is our job to help and make sure that you get the right product for your need. If you have purchased the same items from us previously we can quickly identify it from our sales records.

Our direct sales telephone number to place an order or ask for assistance in selecting a product is 01480 397444. Alternatively you can fax us on 01480 466555 or email us on sales@webtec.co.uk.

We are open for business Monday to Thursday 8.30am to 5.30pm and Friday 8.30am to 4.30pm.

Distributors
We work with distributors, many of whom specialise in particular parts of our product range. For details of your closest distributor please contact us or visit our website.

Opening an Account
If you wish to open a credit account with us please call to request an application form. We also accept VISA and MasterCard. We reserve the right to refuse a credit account without stating a reason.

Packaging and Delivery
Our standard carrier offers next day delivery for most of the UK. Should you require delivery to a remote location in the UK, please call to confirm.

Where an order value exceeds £750 list price, packing and delivery is included anywhere in the UK except for the Scottish Highlands and Islands. For orders less than £750 list, a packing and delivery charge will be added.

Where prices are negotiated for quantities on scheduled deliveries it is practice to sell ex-works and charge delivery and packaging at cost.

Special Delivery

Saturday AM
For Saturday before noon delivery please add £25.00. Price is per parcel, up to 20 kg. Available for most destinations on the UK mainland except Scottish Highlands and Islands.

Guaranteed Before 10.30 AM
For guaranteed next day before 10.30 am delivery, (not Saturdays), please add £17.00. Price is per parcel, up to 20 kg. Available for most destinations on the UK mainland except Scottish Highlands and Islands.

Minimum Order Charge
We have a minimum order charge of £25.00. When the value of the goods ordered is less than this figure we will increase the quantity to make it up to £25.00.

Certificate of Conformity
A certificate of conformity is available from Webtec if requested at the time of ordering, a small charge may be made.

Return of Goods
Provided that you notify us in advance we will accept the return of unused parts and components which are listed in this catalogue, provided they are in good condition and returned carriage paid. Returned goods are subject to a restocking charge of 25% on pumps and motors, 15% on other items. We make cylinders to the stroke and length required by the customer and by their nature they are not easy to change but we will be prepared to quote a restocking charge based on the size and type of cylinder.

Spare Parts
Webtec Products Ltd offer a spare parts service for the majority of products manufactured and supplied. Certain units shown in the catalogue include details of the spare parts that can be ordered. Seal kits can be made available for gear motors and pumps as well as the various types of valve. Please contact the sales department for availability and selling prices.

Repairs
Webtec Products Ltd. offers a repair service for the convenience of our customers. Should you wish to take advantage of this service the following points should be noted.

1) Only items of WEBTEC manufacture or supply can be handled, for which a returns tracking number MUST be requested BEFORE shipping the goods, (Tel: 01480 397444).
2) Units should be dispatched carriage paid to our Nuffield Road works and should be accompanied by an order to repair, stating the returns number and giving details of any fault.
3) It is not possible to offer a standard price for a repair as cost is dependent on the amount of man hours required and parts used. However, if you wish to have an estimate for the cost of repair, this can be provided after stripping and inspecting the returned item.
4) If when carrying out a repair we consider that the cost of repair will exceed 2/3rds of the cost of a new unit, we will advise you that the unit is Beyond Economic Repair (B.E.R.) and you will be invited to decide on the disposal of the unit in one of three ways:

    a) Unit to be scrapped at these works.
    b) Unit to be repaired.
    c) Unit to be returned, you will be liable for costs up to that point plus cost of carriage from these works.

5) A Service Report on each type of unit repaired will be mailed to you at the Invoice point.

6) Goods which have been repaired will come under the cover of para. 20 of our Conditions Of Sale.

Section 2

Hydraulic Flow Control Valves

ILFC Series

Fixed Flow Pressure Compensated Control Valve

Flow Control Valves maintain the flow rate of hydraulic fluid to a specified value.

Applications include hydraulic cylinders required to extend or retract at constant speeds and hydraulic motors required to rotate at constant speeds. When used with a fixed delivery pump the excess flow is By-Passed across a relief valve.

Specifications

Maximum Pressure:
210 bar (working)

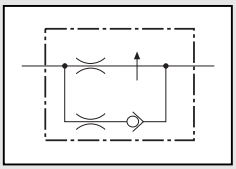
Maximum Flow:
16 lpm

Porting:
BSPP & NPTF - see Table 1

Material:
Zinc plated clear passivate

Weight:
See Table 1

Symbol



Features

- Pressure compensated to ensure a constant flow rate under varying pressures.
- Pre-set in factory to customer requirements at any flow rate between 1.5 lpm - 16 lpm.
- Uncontrolled flow is permitted in reverse direction.
- Zinc plated clear passivate.
- Cartridge version available, without steel body.

Ordering Codes

Typical Code ILFC 16 5 J

ILFC - In-line (fixed) Flow Control

Flow Size (see Table 1)

Factory Preset Flow Rating in lpm

Port Thread (see Table 2)

Table 1: Dimensions

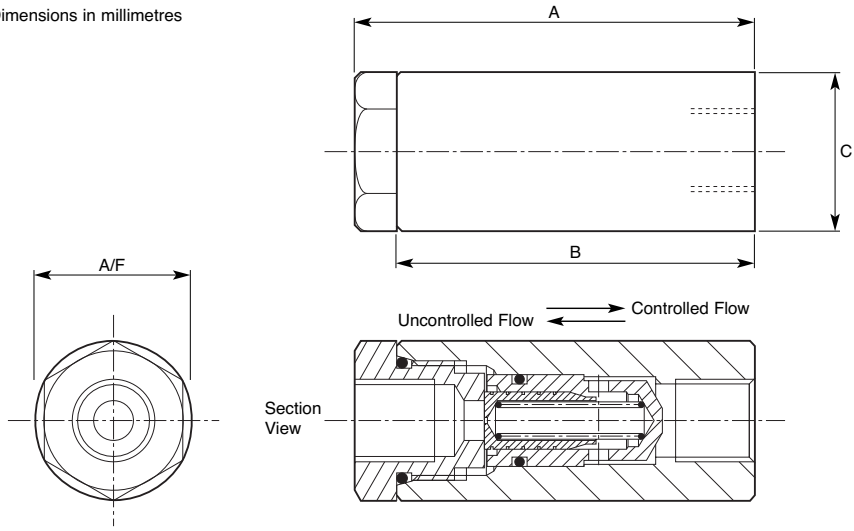
Code	Flow Range	Port		A	B	C	A/F	Weight (kg)
		Size	Thread					
14	1.5 - 14 lpm	1/4"	BSPP	64	57	25	22	0.20
14	1.5 - 14 lpm	1/4"	NPTF	87	62	25	22	0.25
16	1.5 - 16 lpm	3/8"	BSPP	77	57	25	22	0.20
16	1.5 - 16 lpm	3/8"	NPTF	87	62	25	22	0.25

Table 2: Porting*

Code	Thread
J	BSPP
A	NPTF

Installation Details

Dimensions in millimetres



* Other threads available to special order.

VFC Series

Variable Flow Pressure Compensated Control Valve

Variable Flow Control Valves maintain the flow rate of hydraulic fluid to a selected value.

Applications include hydraulic cylinders requiring constant extension or retraction speeds and hydraulic motors requiring constant rotational speeds. When used with a fixed delivery pump the excess flow is By-Passed across a relief valve.

Specifications

Maximum Pressure:
210 bar (working)

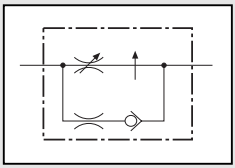
Maximum Flow:
55 lpm

Porting:
BSPP & NPTF

Material:
Steel components in an aluminium body

Weight:
See Table 1

Symbol



Features

- Pressure compensated to ensure a constant flow rate under varying pressures.
- Knurled knob enables fast, accurate adjustment of flow rate in one direction (under pressure) from 1.5 lpm to 55 lpm.
- Knurled knob can be locked in position by a grub (set) screw and provides weatherproof sealing to prevent the adjusting screw from corroding or seizing.
- Free (uncontrolled) flow is permitted in reverse direction.
- Special, Uni-directional version available on request.

Ordering Codes

Typical Code VFC 20 K J

VFC - Variable Flow Control

Flow Size (Table 1)

Adjustment Method (knurled knob)

Porting (Table 2)

Table 1: Dimensions

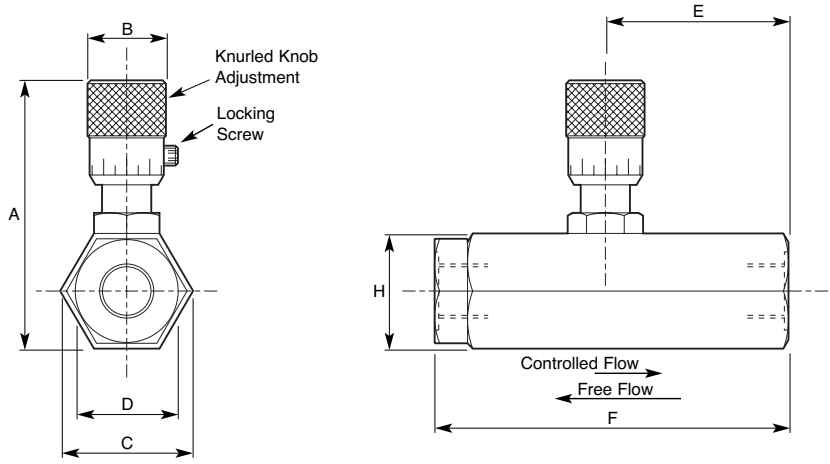
Code	Flow Range	Port Size	A	B	C	D	E	F	H	Weight (kg)
20	1.5 - 20 lpm	1/4"	59.9	17.5	32.8	25.4	44.4	84.8	28.4	0.2
40	2.0 - 40 lpm	3/8"	74.6	23.8	43.9	35.1	57.1	107.1	38.1	0.4
55	2.0 - 55 lpm	1/2"	77.7	23.8	47.5	38.1	63.5	119.1	41.1	0.5

Table 2: Porting *

Code	Thread
J	BSPP
A	NPTF

Installation Details

Dimensions in millimetres



* Other threads available to special order.

FV 120 Series

Fixed Priority Flow Dividers

Priority Type Flow Dividers split a single input flow into a 'Priority' (regulated) flow and a 'By-Pass' (excess) flow which can be returned directly to the oil reservoir or used to power a second system. This often dispenses with the need for another pump to operate a second system.

A common application on mobile machinery is to use the 'Priority' (regulated) flow for power steering and the 'By-Pass' (excess) flow for an implement or lift circuit. This ensures the power steering is satisfied first to keep the steering speed constant.

Specifications

Maximum Pressure:
210 bar (working)

Total Flow Capacity:
76 lpm

Regulated Flow Capacity:
See Table 1, ordering codes

Porting:
See Table 3, ordering codes

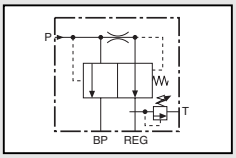
Material:
Steel components in cast iron body

Weight:
1.50 kg

Mounting:
Two bolt

Relief Valve:
See Table 2, ordering code

Symbol



Features

- 'Priority' flow rate is pre-set in factory to customer specifications at any value between 3.78 lpm and 34.1 lpm in increments of 3.78 lpm. Flow through the 'Priority' port will remain constant at the pre-set value as long as input flow equals or exceeds the Priority flow value.
- Pressure compensated permitting both 'Priority' and 'By-Pass' flows to be used simultaneously at varying pressures without effecting the 'Priority' flow rate.
- Built-in pressure relief valve protects the 'Priority' circuit from excess pressure and is adjustable from 34.5 bar to 210 bar (Factory set 82.7 bar unless otherwise specified).

Ordering Codes

Typical Code FV 2 1 20 J

FV - Valve Type

Priority Flow Setting (Table 1)

Relief Valve (Table 2)

20 - Basic Type

Porting (Table 3)

Table 1: Priority Flow

Code	Flow at Priority Port
1	3.78 lpm
2	7.57 lpm
3	11.4 lpm
4	15.1 lpm
5	18.9 lpm
6	22.7 lpm
7	26.5 lpm
8	30.3 lpm
9	34.1 lpm

Table 2: Relief Valve

Code	Description
0	Without Relief Valve
1	With Relief Valve

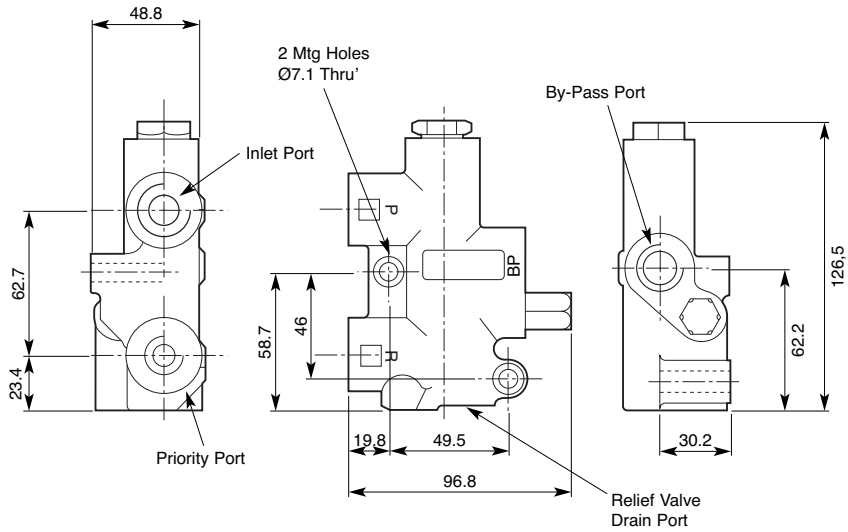
Table 3: Porting

Code	Inlet and By-Pass Port	Priority and Relief Port
A	1/2" NPTF	3/8" NPTF
J	1/2" BSPP	3/8" BSPP
G	7/16" -20UN #4 SAE ORB	9/16" -18UN #6 SAE ORB

Note: Relief Valve can be adjusted between 34.5 bar and 210 bar.
Please specify required setting when ordering otherwise setting will be 82.7 bar.

Installation Details

Dimensions in millimetres



* Other threads available to special order.

FV 200 Series

Proportional Flow Dividers

Proportional Flow Dividers split a single input flow into two output flows, each output being a fixed proportion of the input. For example, a 50/50 flow divider will always split a single input flow into two equal output flows which could be used to operate two motors at equal speeds. The actual rate of flow from each output is not fixed but will vary as the input flow rate varies.

Specifications

Maximum Pressure:
207 bar (workings)

Total Flow Capacity:
76 lpm

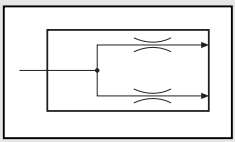
Porting:
See Table 3, ordering codes

Materials:
Steel components in cast iron body

Weight:
1.47 kg

Mounting:
Two bolt

Symbol



Features

- Pressure compensated to keep each output flow at a fixed percentage of the input flow, regardless of pressure variations between the output ports.
- Three standard models are available giving proportional splits of 25 / 75%, 50% / 50% and 40% / 60%. Other proportional splits are available up to 10%/90% (see ordering codes).
- Three flow ranges are available; 10 - 30 lpm, 20 - 50 lpm, 40 - 76 lpm (see ordering codes).

Ordering Codes

Typical Code FV200 30 2 J

FV 200 - Valve Type

Flow Range (Table 1)

Output Flow Proportions (Table 2)

Porting (Table 3)

Table 1: Flow Range

Code	Recommended Flow Range
30	10 - 30 lpm
50	20 - 50 lpm
70	40 - 76 lpm

Table 2: Flow Rates

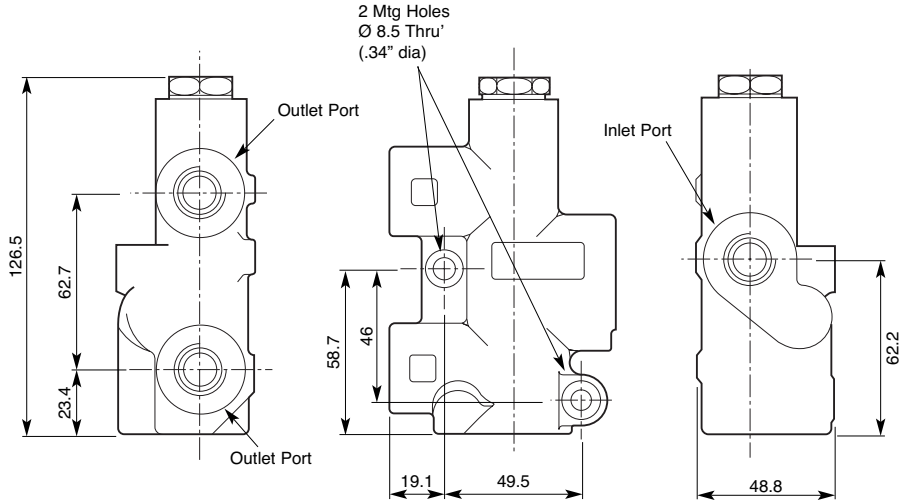
Code	A/B Ratio %
1	25 / 75
2	50 / 50
3	40 / 60
other ratios available up to 10 / 90	

Table 3: Porting

Code	Inlet Port	Outlet Ports
J	1/2" BSPP	3/8" BSPP
S	3/4" BSPP	3/4" BSPP

Note: 'S' Ported Valve

Installation Details



* Other threads available to special order.

VFD 50 Series

Variable Priority Flow Dividers

Priority Type Flow Dividers split a single input flow into a 'Priority' (regulated) flow and a 'By-Pass' (excess) flow which can be returned directly to the oil reservoir or used to power a second system. In many instances this dispenses with the need for another pump to operate a second system.

Specifications

Maximum Pressure:
250 bar (working)

Total Flow Capacity:
50 lpm

Regulated Flow Capacity:
See Table 1, ordering codes

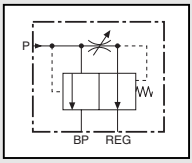
Porting:
See Table 2, ordering codes

Material:
Steel components in cast iron body: aluminium knob.

Weight:
0.75 kg

Mounting:
2 Bolt - BSPP or NPTF Ported
3 Bolt - Manifold

Symbol



Features

- Clearly marked hand-dial permits fast visual adjustments to pre-determined 'Priority' flow and fast easy adjustment of 'Priority' circuit to meet varying requirements.
- Pressure compensated permitting both 'Priority and 'By-Pass' flows to be used simultaneously at varying pressures without effecting the Priority flow rate.

Ordering Codes

Typical Code VFD50 30 T

Valve Type

Regulated Flow Capacity (Table 1)

Porting (Table 2)

Table 1: Regulated Flow

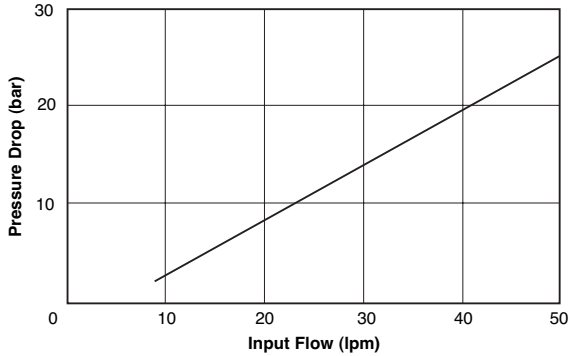
Code	Regulated Flow
15	0 - 15 lpm
30	0 - 30 lpm

Table 2: Porting*

Code	Port Type
T	3/8" BSPP x 3 Ports
M	Manifold Mounted
A	3/8" NPTF x 3 Ports

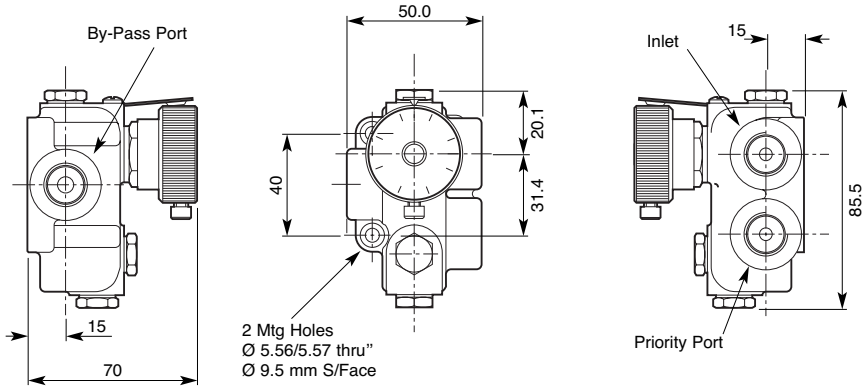
Typical Pressure Drop VFD 50 Series

Curve established using hydraulic mineral oil ISO 32 with viscosity of 21 centistokes at 50°C



Installation details

Dimensions in millimetres



* Other threads available to special order.

2FV2V Series

Variable Priority Flow Dividers

Priority Type Flow Dividers split a single input flow into a 'Priority' (regulated) flow and a 'By-Pass' (excess) flow which can be returned directly to the oil reservoir or used to power a second system. In many instances this dispenses with the need for another pump to operate a second system.

Specifications

Maximum Pressure:
250 bar (working)

Total flow capacity:
114 lpm

Regulated flow capacity:
See Table 2, ordering codes

Porting:
See Table 3, ordering codes

Material:
Steel components in cast iron body painted black; aluminium knob (steel knob optional)

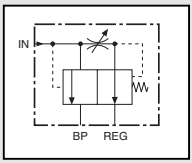
Weight:
2.10 to 3.50 Kg

Mounting:
Two bolt - M8 or 5/16"
(Except manifold version which uses 4 bolts)

Relief valve (optional):
Adjustable between 35 - 207 bar
Max. Priority flow - 50 lpm

Check valve (optional):
250 bar working pressure
(Anti-cavitation check valve available)

Symbol



Features

- Clearly marked single-turn hand dial permits fast visual adjustments to pre-determined 'Priority' flow and fast easy adjustments of 'Priority' circuit to meet varying requirements.
- Pressure compensated permitting both 'Priority' and 'By-Pass' to be used simultaneously at varying pressures without affecting the 'Priority' flow rate.
- All models (except manifold mount) can be supplied with an adjustable pressure relief valve or check valve on 'Priority' flow. Anti-cavitation check valve can be routed between the 'By-Pass' and 'Priority' flows.
- Anti-tamper locknut option available for all models, Contact Sales Office for more information.
- For intermittent reverse flow, needle valve 'pull back' facility available on request.
- Remote control versions available see 2.17 & 2.19

Ordering Codes

Typical Code M 2FV2V 125 J ( )

Manifold mounting available on 2FV2V model only

Valve Type (Table 1)

Regulated Flow Capacity (Table 2)

Porting (Table 3)

Pressure Setting (bar, if Relief Valve required)

Table 1: Valve Type

Code	Description
2FV2V	No Relief Valve
RV2FV2V	Relief Valve between Priority and By Pass Flow Port
RVXD2FV2V	Externally Drained Relief Valve
CK2FV2V	Check Valve between Priority and Inlet Flow Port
AC2FV2V	Anti-cavitation Check Valve between By-Pass and Priority Flow Port
M2FV2V	Manifold Mounted
PB2FV2V	Pull Back Poppet

Table 2: Regulated Flow

Code	Regulated Flow
030	0 - 11 lpm
050	0 - 19 lpm
080	0 - 30 lpm
125	0 - 47 lpm
200	0 - 76 lpm
250	0 - 95 lpm
300	0 - 114 lpm

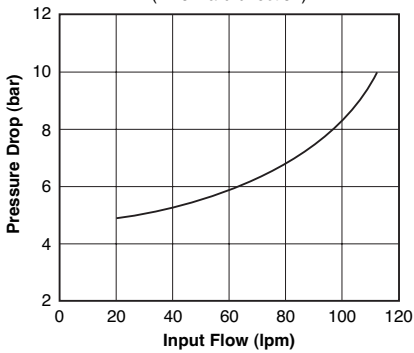
Table 3: Porting*

Code	Port Threads Inlet Regulated Flow and Excess Flow	Relief Valve External Drain where fitted
J	$^{3}/_{4}$" BSPP	$^{1}/_{4}$" BSPP
A	$^{3}/_{4}$" NPTF	$^{1}/_{4}$" NPTF
M	M22 x 1.5, M27 x 2	M14 x 1.5
G	1-$^{1}/_{16}$" -12UN #12 SAE ORB	$^{9}/_{16}$" -18UN #6 SAE ORB
H	$^{1}/_{2}$" BSPP	$^{1}/_{4}$" BSPP
K	Manifold mounted (custom hole pattern)	N/A

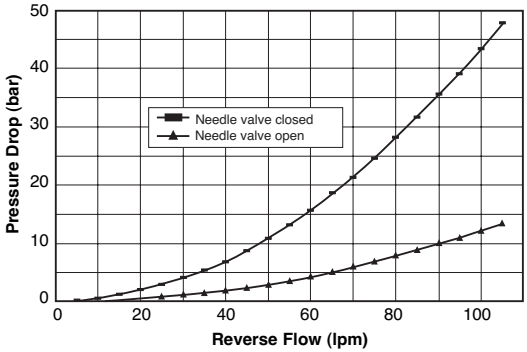
* Other threads available to special order.

Note: M22 only available in flow code 030 to 125
M27 only available in flow code 200 to 300
$^{1}/_{2}$" BSPP only available in flow code 030 to 125

Typical Pressure Drop 2FV2V Series
(in forward direction)

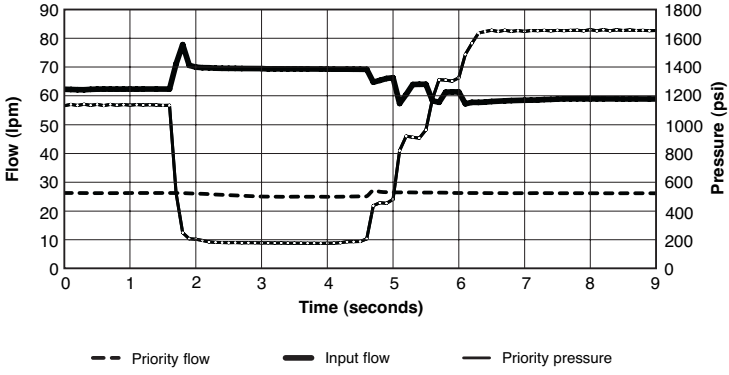


Typical Pressure Drop CK2FV2V Series
(in reverse direction)



Curve established using hydraulic mineral oil ISO 32 with viscosity of 21 centistokes at 50°C

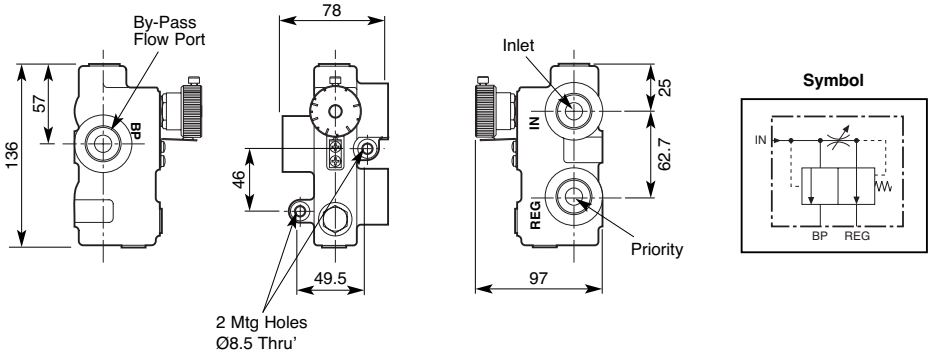
Typical flow control performance - varying input conditions



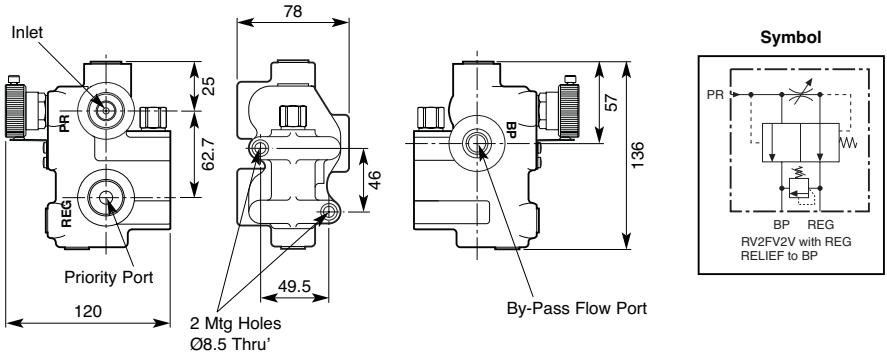
Installation Details

Dimensions in millimetres

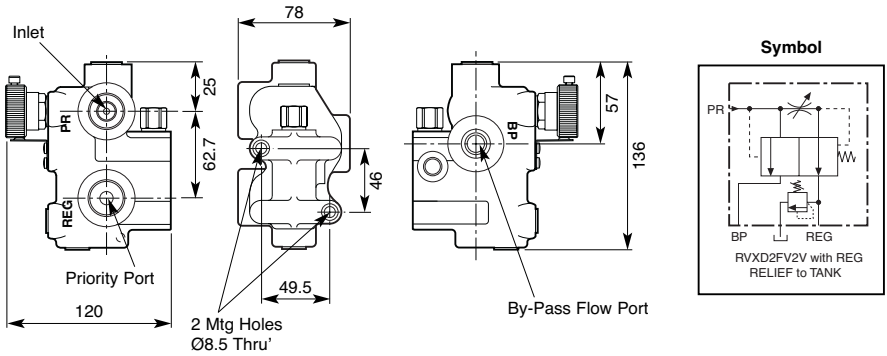
(PB) 2FV2V (No Relief Valve)



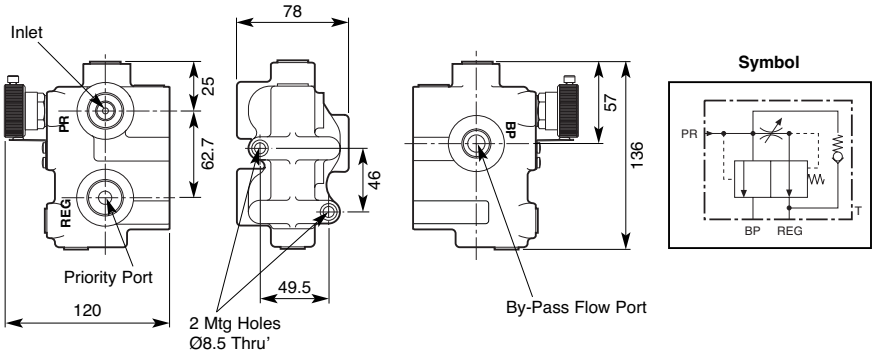
RV2FV2V (Internal Relief Valve between Priority and By-Pass Flow Ports)



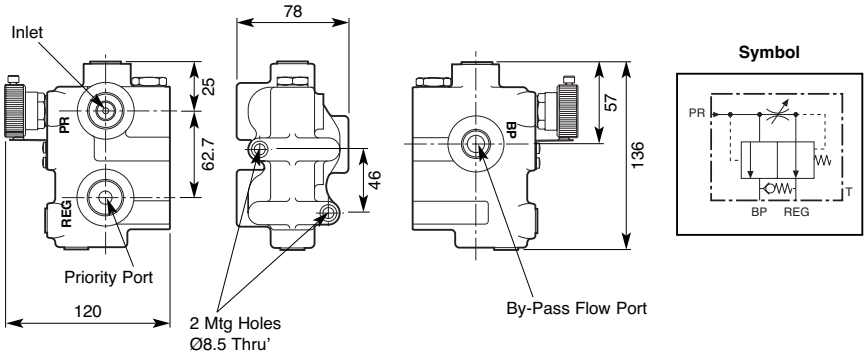
RVXD2FV2V (Externally drained Relief Valve)



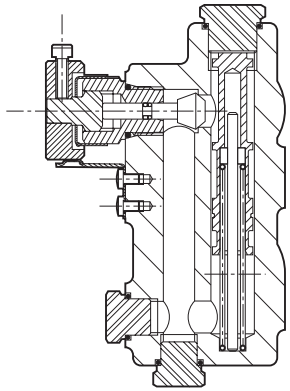
CK2FV2V (Internal Check Valve between the Priority and Inlet Flow Ports)



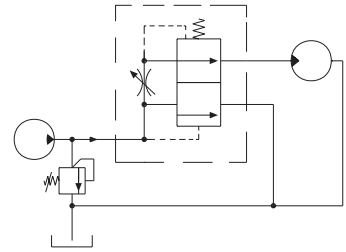
AC2FV2V (Internal Anti-cavitation Check Valve between the By-Pass and Priority Flow Ports)



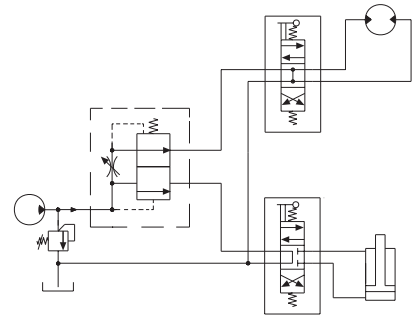
Sectioned View



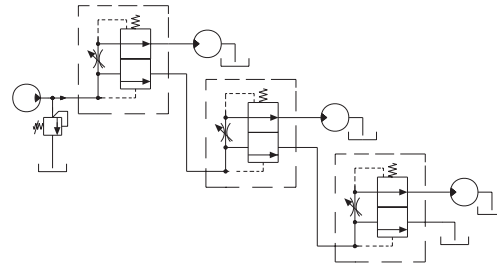
Circuit 1



Circuit 2



Circuit 3



Circuit Suggestions

1 Variable Speed of Hydraulic Motor Drive on Agricultural Tractor

This circuit gives the capability to vary the speed of a hydraulic motor as required. Also, for a given control knob setting, the hydraulic motor speed stays constant regardless of the tractor speed.

2 Two Circuits From a Single Pump

Using only one pump, this circuit gives speed control of the hydraulic motor and powers a hydraulic cylinder. Each function can be used either simultaneously or independently because pressure variations between regulated and By-Pass flows do not effect the flow on the regulated circuit.

3 Multiple Circuits From a Single Pump

Using one pump, this circuit gives independently variable speed drive from three hydraulic motors. Motors can be used simultaneously or independently.

2FV2V Series

Variable Priority Flow Divider with Electric Motor Drive

Priority Type Flow Dividers split a single input flow into a 'Priority' (regulated) flow and a 'By-Pass' (excess) flow which can be returned directly to the oil reservoir or used to power a second system. In many instances this dispenses with the need for another pump to operate a second system.

Specifications

Maximum Pressure:
250 bar

Total Flow Capacity:
114 lpm

Regulated Flow Capacity:
See Table 2, ordering codes

Porting:
See Table 1

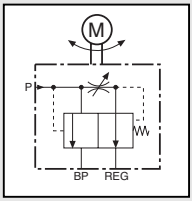
Material:
Steel components in cast iron body painted black

Weight:
2.75 kg

Power Supply:
12V (24V at special request)

Peak Current:
1.0 Amp

Symbol



Features

- Minimum to full Priority flow in 15 seconds.
- Powered from Nom. 12 VDC (12 - 16 VDC).
- Electric motor drive permits adjustment from a position away from the valve such as a cab or a control panel.
- Pressure compensated permitting both 'Priority' and 'By-Pass' flows to be used simultaneously at varying pressures without effecting the 'Priority' flow rate.
- Can be used as unidirectional two port in line flow control by plugging the 'By-Pass' flow port. (**Note:** in this configuration a relief valve must be used on the inlet line).
- 24 volt versions available on request

Ordering Codes

Typical Code 2FV2V 125 J E

Valve Type

Regulated Flow Capacity (Table 2)

Porting (Table 1)

Motor Drive

Table 3: Porting*

Code	Port Threads Inlet Regulated Flow and Excess Flow	Relief Valve External Drain where fitted
J	3/4" BSPP	1/4" BSPP
A	3/4" NPTF	1/4" NPTF
M	M22 x 1.5, M27 x 2	M14 x 1.5
G	1-1/16" -12UN #12 SAE ORB	9/16" -18UN #6 SAE ORB
H	1/2" BSPP	1/4" BSPP

* Other threads available to special order.

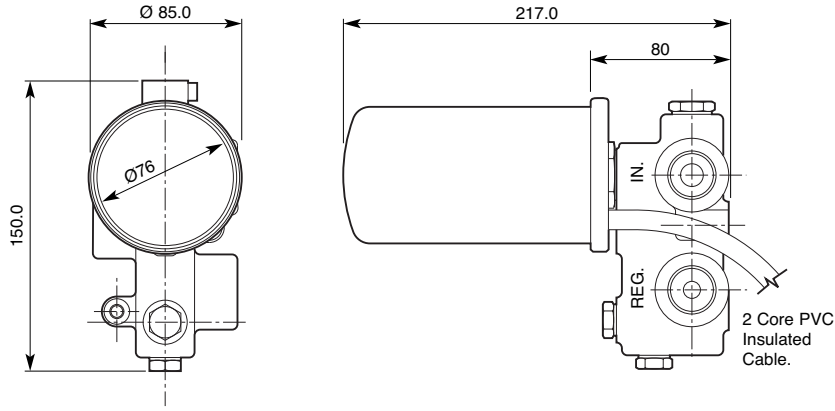
Note: M22 only available in flow code 030 to 125
M27 only available in flow code 200 to 300
1/2" BSPP only available in flow code 030 to 125

Table 2: Regulated Flow

Code	Regulated Flow
030	0.5 - 11 lpm
050	0.5 - 19 lpm
080	0.5 - 30 lpm
125	0.5 - 47 lpm
200	0.5 - 76 lpm
250	0.5 - 95 lpm
300	0.5 - 114 lpm

Installation Details

Dimensions in millimetres



Power supply to		
Blue Cable	Brown Cable	Function
-ve	+ve	Valve opens
+ve	-ve	Valve closes

FDM Series

Variable Priority Flow Divider with Remote Proportional Control

The FDM remote control flow divider is ideally suited for the agricultural and industrial user seeking a cost-effective method of controlling hydraulic motor speed. The priority flow port gives an output independent of load pressure while the By-Pass port can be used to power a secondary circuit.

Specifications

Maximum pressure:
250 bar

Total flow capacity:
114 lpm

Regulated flow capacity:
See Table 2

Porting:
See Table 1

Material:
Steel components in a cast iron body.
Drive mechanism mounted on aluminium supports

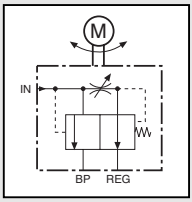
Weight:
2.75 kg

Power supply:
9 - 28 V

Peak current:
2.5 A

Average current:
< 100 mA

Symbol



Features

- Minimum to maximum priority flow in less than 3 seconds (at full pressure)
- 9 - 28 V D.C. supply enables unit to be powered from a vehicle supply
- Remote control using:
  Potentiometer (shown above)
  0 - 5 VDC
  4 - 20 mA loop
- Remote operating distance: up to 40 m
- Pressure compensated permitting both 'priority' and 'By-Pass' flow to be used simultaneously at varying pressures without affecting the 'priority' flow rate
- Automatic current limiting to prevent overheating and motor overload
- Valve settings immune to power failure
- Tolerant to vibration and oil contamination
- Valve cover zinc plated and Teflon® coated for corrosion resistance
  Teflon® is a Registered Trademark of DuPont
- Designed to meet IP67
- Range of cables available please contact sales office

Ordering Codes

Typical Code FDM 125 J P

Valve Type

Regulated Flow Capacity (Table 2)

Porting (Table 1)

Control (Table 3)

Table 1: Porting*

Code	Port Threads Inlet Regulated Flow and Excess Flow	Relief Valve External Drain where fitted
J	3/4" BSPP	1/4" BSPP
A	3/4" NPTF	1/4" NPTF
M	M22 x 1.5, M27 x 2	M14 x 1.5
G	1-1/16" -12UN #12 SAE ORB	9/16" -18UN #6 SAE ORB
H	1/2" BSPP	1/4" BSPP

* Other threads available to special order.

Note: M22 only available in flow code 030 to 125
M27 only available in flow code 200 to 300
1/2" BSPP only available in flow code 030 to 125

Table 2: Regulated Flow

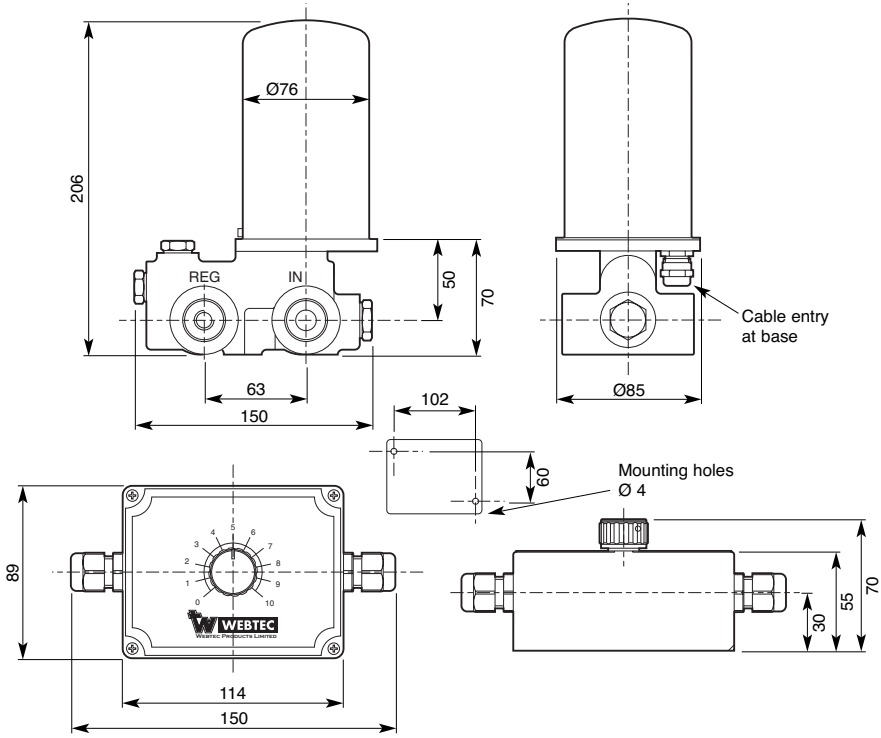
Code	Regulated Flow
030	0.5 - 11 lpm
050	0.5 - 19 lpm
080	0.5 - 30 lpm
125	0.5 - 47 lpm
200	0.5 - 76 lpm
250	0.5 - 95 lpm
300	0.5 - 114 lpm

Table 3: Control

Code	Control
P	Potentiometer
5 V	0 - 5 VDC
mA	4 - 20 mA

Installation Details - Value

Dimensions in millimetres



*Other threads available to special order.

M2FV2V Series

Manifold Mounted Variable Priority Flow Divider

Priority Type Flow Dividers split a single input flow into a 'Priority' (regulated) flow and a 'By-Pass' (excess) flow which can be returned directly to the oil reservoir or used to power a second system. In many instances this dispenses with the need for another pump to operate a second system.

Specifications

Maximum Pressure:
250 bar (working)

Total Flow Capacity:
114 lpm

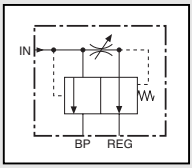
Regulated Flow Capacity:
See Table 1, ordering codes

Material:
Steel components in cast iron body

Weight:
2.75 kg

Mounting:
4 Bolt Manifold

Symbol



Features

- Pressure compensated permitting both 'Priority' and 'By-Pass' flows to be used simultaneously at varying pressures without affecting the 'Priority' flow rate.
- Can be used as uni-directional two port in line flow control by plugging the 'By-Pass' flow port. (**Note:** in this configuration a relief valve must be used on the inlet line).
- Manifold Mounted.
- Anti-tamper locknut option available for all models, Contact Sales Office for more information.
- For intermittent reverse flow, needle valve 'pull back' facility available on request.

Ordering Codes

Typical Code M 2FV2V 125 K

Manifold Mounted

Valve Type

Regulated Flow Capacity (Table 1)

Control Type (Table 2)

Table 1: Regulated Flow

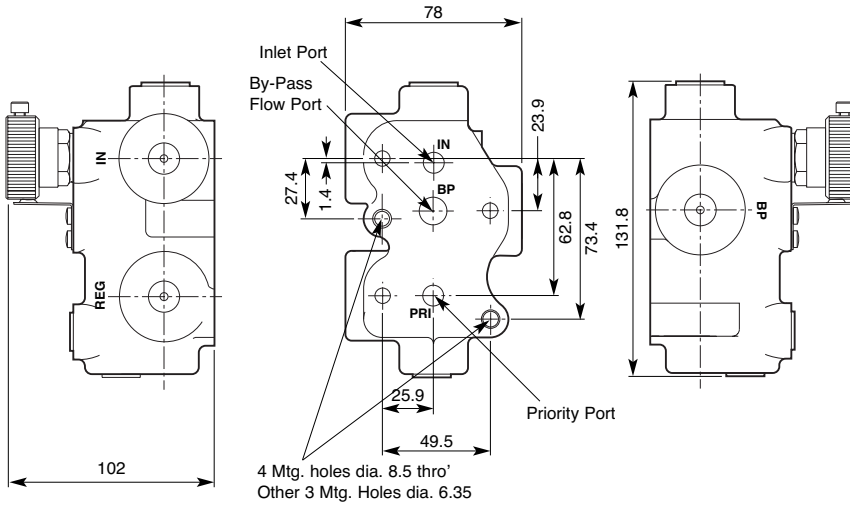
Code	Control Type 'K'
030	0 - 11 lpm
050	0 - 19 lpm
080	0 - 30 lpm
125	0 - 47 lpm

Table 2: Porting

Code	Description
K	Manifold Mounted

Installation Details ('K' Type)

Dimensions in millimetres



FDC 60 Series

Flow Divider Combiner

A Flow Divider-Combiner will divide a single flow into two separate flows which will always be in the same ratio to each other regardless of any pressure differential between the two lines. If the flow is reversed (e.g. return stroke of two cylinders) the return flows are held in the same ratio to each other and combined into a single flow, regardless of individual loads on the cylinders

A common application is to keep two cylinders (or motors) in close unison when loads on them are unequal. The valves may also be used in series to operate more than two circuits.

Specifications

Maximum Pressure:
310 bar (working)

Total Flow Capacity:
70 lpm

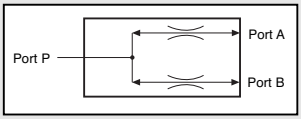
Porting:
See Table 2, ordering codes

Materials:
Steel components in cast iron body

Weight:
2.05 kg

Mounting:
Three bolt

Symbol



Features

- Pressure compensated to keep the two divided flow rates at the same ratio regardless of pressure variations between them.
- Flow ratios are pre-set at factory from 50% - 50% up to 10% - 90%.
- Flow ranges are available from 5 lpm to 70 lpm.
- Cast iron/hardened steel construction (no aluminium) makes it suitable for mining applications.

Ordering Codes

Typical Code FDC 60 10 3 A40% B60%

FDC 60 - Valve Type

Recommended Flow Range (Table 1)

Porting (Table 2)

Divider Ratio (Table 3)

Table 1: Recommended Flow Range

Code	Flow Range
05	2 - 5 lpm
10	5 - 10 lpm
20	8 - 20 lpm
30	16 - 30 lpm
40	25 - 40 lpm
50	35 - 50 lpm
60	45 - 60 lpm
70	55 - 70 lpm

Table 3: Divider Ratio

A		B
50%		50%
	thru'	
10%		90%

Note: Either outlet port (A or B) may be designated to take either leg of the ratios.

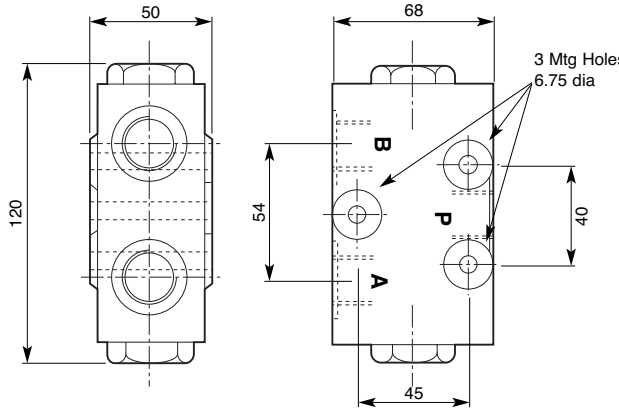
The example shown designates 40% at A and 60% at B. Any ratio from 50% - 50% to 90% - 10% may be specified.

Table 2: Porting (choose from following codes)

Code	Port P	Port A	Port B
1	M18 x 1.5	M18 x 1.5	M18 x 1.5
2	M22 x 1.5	M18 x 1.5	M18 x 1.5
3	3/8" BSPP	3/8" BSPP	3/8" BSPP
4	1/2" BSPP	3/8" BSPP	3/8" BSPP
5	1/2" BSPP	1/2" BSPP	1/2" BSPP
6	7/8" -14UN #10 SAE ORB	3/4" -16UN #8 SAE ORB	3/4" -16UN #8 SAE ORB
7	M27 x 2	M22 x 1.5	M22 x 1.5
8	1/2" NPTF	1/2" NPTF	1/2" NPTF

Installation Details

Dimensions in millimetres



* Other threads available to special order.

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Section 3

Hydraulic Directional Control Valves and Check Valves

SV80 Series

Diverter Valve

A Diverter Valve provides an alternative to the standard directional control valve when a neutral (centre) position is not required. It allows flow to be directed into either of two lines which enables fast changing from one system to another, or from one system to tank thus providing an idling circuit.

Other applications may be as a safety lock preventing accidental operation of separate functions which should not operate together and the selection of attachments as on a farm tractor.

Specifications

Maximum Working Pressure:
210 bar

Maximum Flow:
80 lpm

Porting:
See Table 2, ordering codes

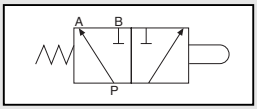
Material:
Stainless steel spool in cast iron body

Weight:
2 kg (approx.)

Mounting:
Two bolt

Symbol

For valve model number SV80-A-J-S (see ordering codes)



Features

- Flow may be directed by mechanically pushing the spool with spring offset or by a mechanical push pull operation in which case the valve stem is threaded or fitted with a moulded knob.
- Customer can select from one of two spool types allowing flow to be diverted from one line to another or from system to tank.
- A choice of port threads are available.
- Special versions also available.

Ordering Codes

Typical Code SV80 A J S

Basic Valve

Spool Type (Table 1)

Porting (Table 2)

Operation (Table 3)

Table 1: Spool Type

Code	Spool Type
A	
B	

Table 2: Porting

Code	Porting
J	1/2" BSPP
G	7/8" -14UN #10 SAE ORB
M	M22 x 1.5
A	1/2" NPTF

Table 3: Operation

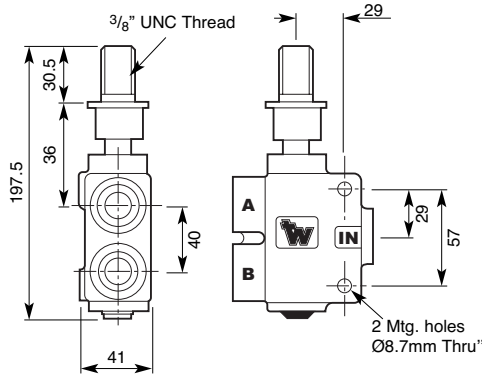
Code	Operation
S	Spring Offset, Mechanical Push
M	Manual, Push - Pull
T	Threaded, Push - Pull

Installation Details

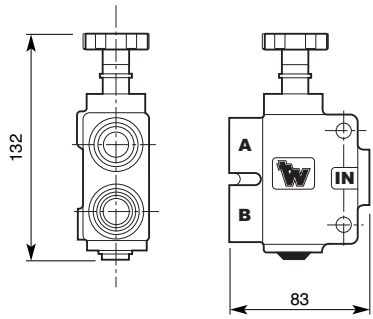
Dimensions in millimetres

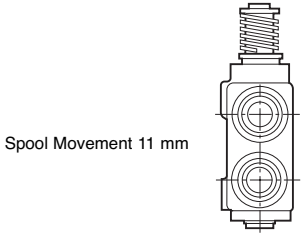
'A' Spool - Inlet to Port 'A' in position shown below
'B' Spool - All Ports closed in position shown below

Threaded Push, Pull Type

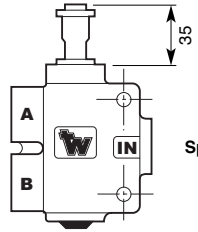


Manual Push, Pull Type





Spool Movement 11 mm



Spring Offset Type

DV80 Series

Diverter Valve

A Diverter Valve provides an alternative to the standard directional control valve when a neutral (centre) position is not required. It allows flow to be directed into either of two lines which enables fast changing from one system to another, or from one system to tank thus providing an idling circuit.

Other applications may be as a safety lock preventing accidental operation of separate functions which should not operate together and the selection of attachments as on a farm tractor.

Specifications

Maximum Working Pressure:
210 bar

Maximum Flow:
80 lpm

Porting:
See Table 2, ordering codes

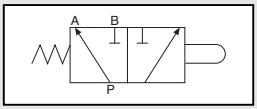
Material:
Stainless steel spool in cast iron body

Weight:
2 kg (approx.)

Mounting:
Two bolt

Symbol

For valve model DV80-A-J-B (see ordering codes)



Features

- Flow may be directed by mechanically pushing the spool with spring offset.
- Customer can select from one of two spool types allowing flow to be diverted from one line to another or from system to tank.
- A choice of port threads and spool end types are available.
- Spring and spool end protected from environment in sealed housing.
- Special versions also available

Ordering Codes

Typical Code DV80 A J R

Basic Valve

Spool Type (Table 1)

Porting (Table 2)

Spool End Type (Table 3)

Table 1: Spool Type

Code	Spool Type
A	
B	

Table 2: Porting

Code	Porting
J	1/2" BSPP
G	7/8" -14UN #10 SAE ORB

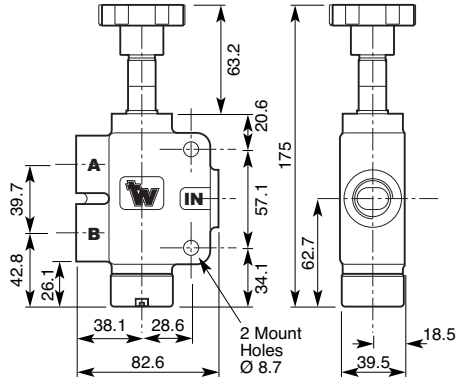
Table 3: Spool End Type

Code	Spool end type
R	Roller
B	Ball
M	Manual

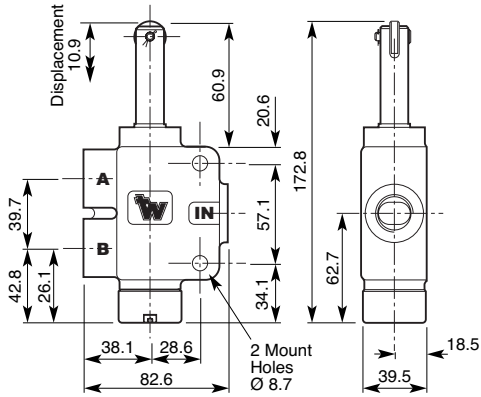
Installation Details

Dimensions in millimetres

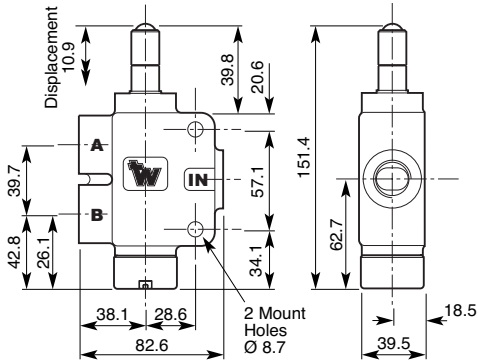
'A' Spool - Inlet to Port 'A' in position shown below
'B' Spool - All Ports closed in position shown below



Manual Push, Pull Type



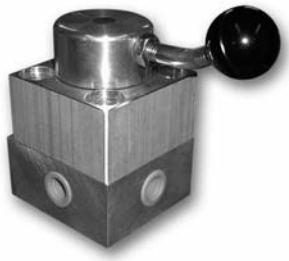
Roller Spring Offset



Ball Spring Offset

180 Series

Manual Directional Control Valve



The Directional Control Valve of the rotary spool type consists of a rotor which is rotated with respect to the valve body. When the rotor is placed in selected positions inlet and outlet ports are connected in various combinations permitting the start, stop or directional change of fluid under pressure. The functions specific to a valve depends primarily on rotor type selected.

Specifications

Maximum Working Pressure:
700 bar
Spring centred models will not spring return to centre when operated over 207 bar.

Maximum Flow:
38 lpm
See table 3, ordering codes for available flow sizes.

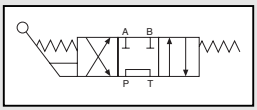
Porting:
See Table 2, ordering codes

Material:
Steel components in aluminium body

Weight:
1.13 kg

Mounting:
Pipe or manifold in any position

Symbol



Features

- Pressure loaded seats working against optically flat rotors automatically compensated for valve wear to assure near zero leakage even after more than 500,000 cycles.
- Customer can select from numerous variations including 7 flow patterns, 3 flow ratings, many porting configurations, ball or offset ball operating handles, spring centring and detents.
- Valves may be in-line, panel or manifold mounted.
- Valve can be used in series without drain up to a max working pressure of 250 bar.

Ordering Codes

Typical Code 180 E I F

Valve Model (Table 1)

Port Size and Location (Table 2)

Flow Size (Table 3)

Handle Type and Rotor Action (Table 4)

Note: Models 185 and 187 available in 1 and 2 flow sizes only

Table 1: Valve Model

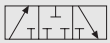
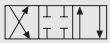
Code	Symbol
180	
181	
182	
183	
184	
185	
187	

Table 2: Port Size and Location

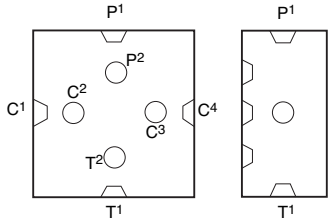
Code	C1	C2	C3	C4	P1	P2	T1	T2	Thread type
A	3/8" ●	1/4"	1/4"	3/8" ●	3/8" ●	1/4"	3/8" ●	1/4"	3/8" = 3/8" BSPP 1/4" = 1/4" NPTF
C*	3/8" ●	.0	0	3/8" ●	3/8" ●	0	3/8" ●	0	
E	3/8"	1/4" ●	1/4" ●	3/8"	3/8"	1/4" ●	3/8"	1/4" ●	
F	3/8" ●	1/4"	1/4"	3/8" ●	3/8" ●	1/4"	3/8" ●	1/4"	3/8" = 3/8" NPTF 1/4" = 1/4" NPTF
K*	3/8" ●	.0	0	3/8" ●	3/8" ●	0	3/8" ●	0	
L	3/8"	1/4" ●	1/4" ●	3/8"	3/8"	1/4" ●	3/8"	1/4" ●	

Note:

0 = C'Bore for 014 'O' Ring (4 'O' Rings included)

● = Ports shipped plugged

* Manifold mounted models utilise 5/16 - 18 UNC through bolts provided for mounting to manifold ('C' porting only)



Typical Performance Drop Curve

Established using Hydraulic oil with viscosity of 27.4 centisokes at 49°C

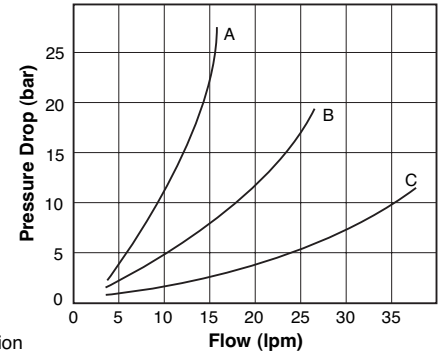


Table 3: Flow Size

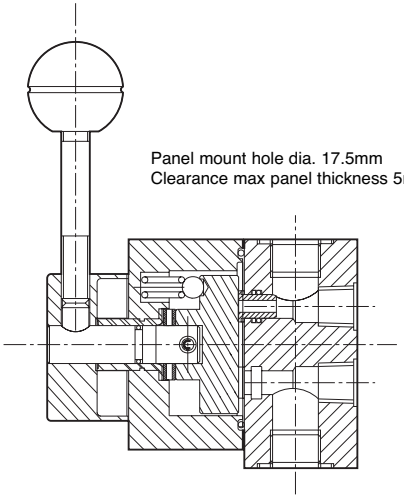
Code	Description	Curve
		MAX Pressure
0	15 lpm Non - interflow*	A 10,000 psi
1	26.5 lpm Low Interflow*	B 5,000psi
2	38 lpm Medium Interflow*	C 3,000psi

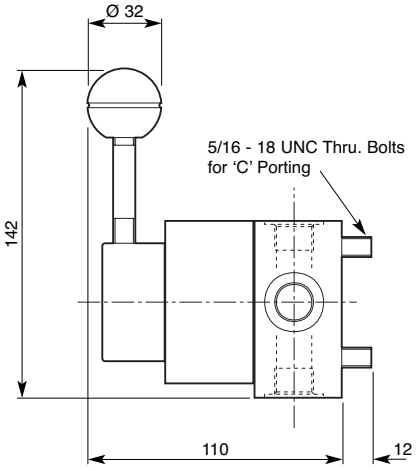
*Interflow = flow through valve in intermediate position

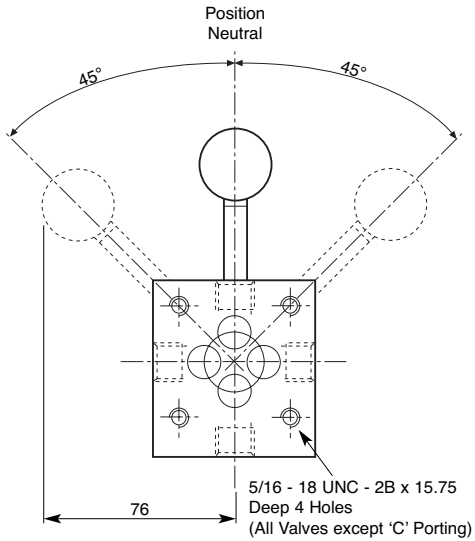
Table 4: Handle Type & Rotor Action

Code	Type	Action
D	Ball	Detented Action
E	Ball	Spring Centred Action
F	Offset Ball	Detented Action + Panel Mount
G	Offset Ball	Spring Centred Action + Panel Mount

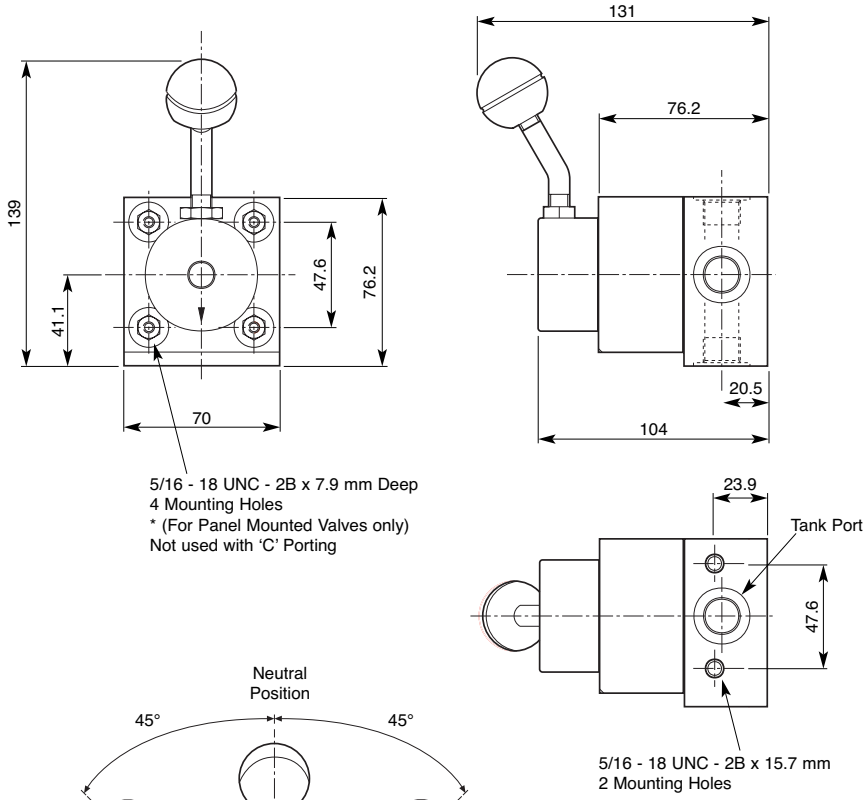
Sectional View







Installation Details
Panel Mounted
Dimensions in millimetres



NR Series

Non-Return Valve

Check (Non-Return) Valves stop fluid flow in one direction while permitting free flow in the opposite direction. The force exerted by fluid entering the valve in the 'free flow' direction unseats a spring loaded poppet permitting fluid to pass. The fluid pressure required to unseat the poppet is known as the 'cracking' pressure. Both the spring force and the fluid force in the opposite direction push the poppet against the seat thus preventing fluid passage.

Specifications

Maximum Working Pressure:
210 bar

Cracking Pressure:
See Table 2, ordering codes

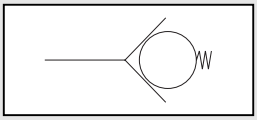
Rated Flow:
See Table 1, ordering codes

Porting:
See Table 1, ordering codes

Material:
Steel body

Weight:
See Table 1, ordering codes

Symbol



Features

- Straight through porting allows the valve to be connected directly in-line thus making the best use of restricted space.
- Customer can select from 7 valve sizes offering a range of flow ratings from 15 - 260 lpm and 4 'cracking' pressure settings ranging from 0.35 to 4.5 bar.

Ordering Codes

Typical Code NR 25 5

NR - Non-Return Valve

Valve Size (Table 1)

Cracking Pressure (Table 2)

Table 1: Valve Size

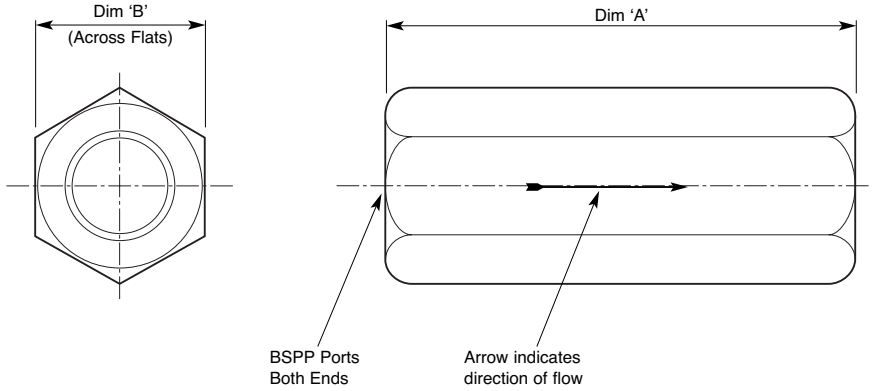
Code	Port Size	Weight	Rated Flow	Dim 'A'	Dim 'B'
25	1/4" BSPP	0.14 kg	15 lpm	6	21.00
37	3/8" BSPP	0.18 kg	27 lpm	70	23.81
50	1/2" BSPP	0.33 kg	52 lpm	76	28.57
75	3/4" BSPP	0.71 kg	85 lpm	108	38.00
100	1" BSPP	0.9 kg	105 lpm	129	42.42
125	1 1/4" BSPP	2.3 kg	175 lpm	133	63.50
150	1 1/2" BSPP	2.3 kg	260 lpm	135	65.07

Table 2: Cracking Pressure

Code	Pressure
5	0.35 bar
15	1.03 bar
30	2.07 bar
65	4.5 bar

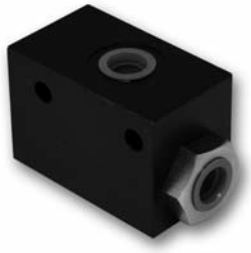
Installation Details

Dimensions in millimetres (see table 1 above)



SHV

Shuttle Valve



The Shuttle Valve permits either of two input flows to be directed to a common outlet port. Flow entering one of the inlets causes a steel ball to travel along a centre bore to seal off the alternative inlet whilst leaving the outlet port free and allowing unimpeded oil flow through the valve.

Specifications

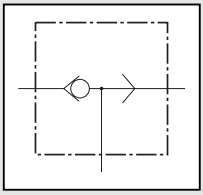
Maximum Working Pressure:
250 bar

Maximum Flow:
20 lpm

Porting:
1/4" BSPP

Material:
Body and adaptor chemically blacked steel. Steel ball.

Symbol



Features

- Fast switching between 2 inlet flows.
- Free flow between inlet and outlet ports.
- 2 bolt mounting.
- Chemically blacked finish.

Ordering Codes

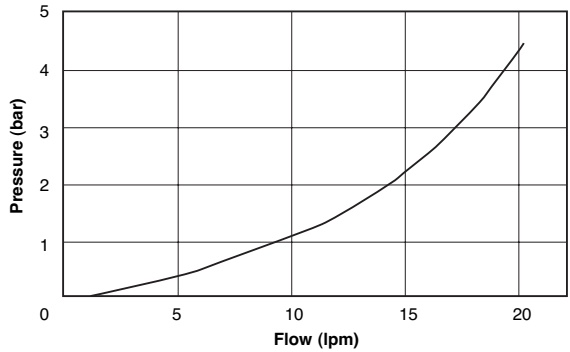
Typical Code SHV 20 J

SHV - Shuttle Valve

20 - Flow Rating

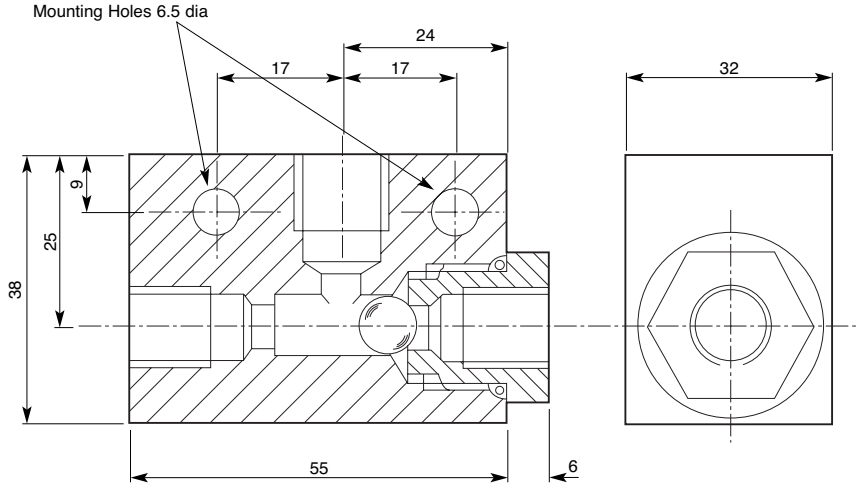
J - 1/4" BSPP Porting

Typical Performance



Installation Details

Dimensions in millimetres



BG4D 1/2” BSPP

Lever Operated Directional Control Valve

Description

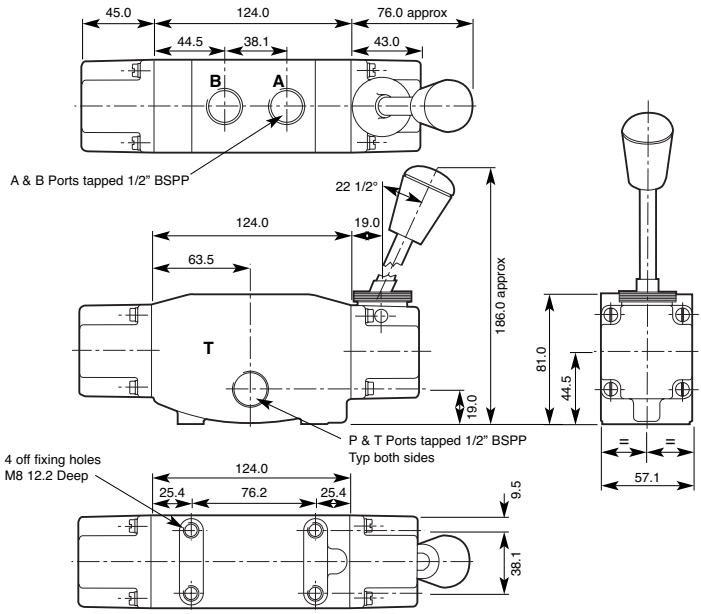
- Nominal flow rate - 55 lpm (see graph for further details)
- Max. operating pressure - 350 bar
- Max. pressure on ‘T’ port - 350 bar
- Recommended operating viscosity range - min. 13 c/st - max 800 c/st
- Recommended operating temperature range - min. -30°C - max 80°C
- Recommended filtration - 25 microns or better
- Seals medium nitrile (consult Technical Sales for alternatives)
- Leakage - typical max. allowable on works test 15cc at 135 bar, oil 35 c/st at 40°C
- Mounting unrestricted

Directional functions

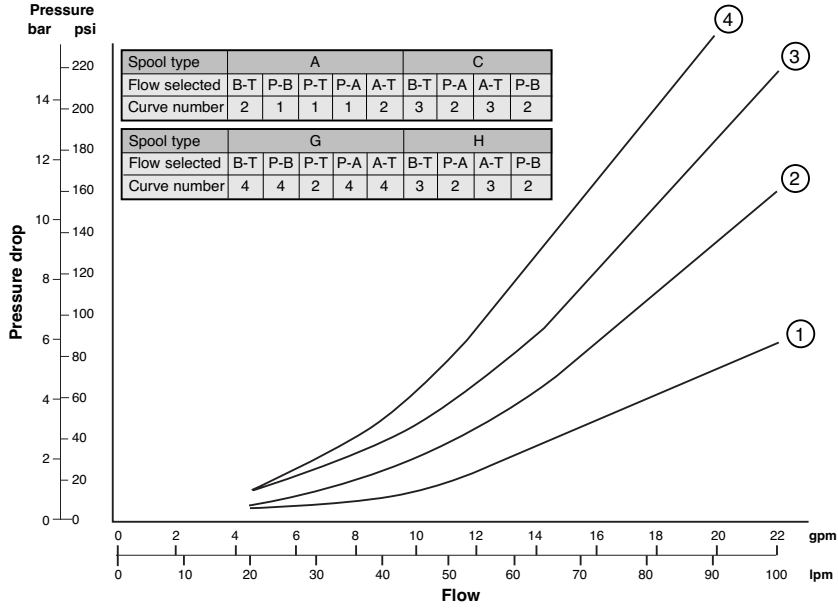
- N.B. Lever fitted on ‘A’ Port end
- Lever pulled away from valve ‘P’ to ‘A’
- Lever pushed towards valve ‘P’ to ‘B’
- Force required to move lever at standard knob centre - 4.5kg

General Arrangement

Weight: 4.5 kg



Pressure Drop Curve



Spool type	A					C			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	2	1	1	1	2	3	2	3	2

Spool type	G					H			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	4	4	2	4	4	3	2	3	2

Ordering Code

Preferred standard
Others to order

Spool Type	
	A
	C
	G
	H
	I
	J

Special	
Spring centred. 3 position	4
Spring centred. 2 position. Stop in lever cap	B
Spring centred. 2 position. Stop in end cap	C
Detent. 3 position	3
Detent. 2 position. Stop in lever cap	E
Detent. 2 position. Stop in end cap	F
Spring offset. P to B 2 position. Stop in end cap.	H
Microswitch fitted ACGH spools spring centred only	

Lever type	
Standard 22 1/2" Lever. Facing up-direction of ports.	E
90° Lever. Facing up-direction of ports.	H
Eye-end Lever. Facing up-direction of ports.	J
Straight Lever. Facing up-direction of ports.	A
As 'E' but facing down. Opposite ports.	B
As 'H' but facing down. Opposite ports.	G
As 'J' but facing down. Opposite ports.	F
As 'A' but facing down. Opposite ports.	K

Pilot operated Service Port Lock Addition. A or H Spools only	
Lock on Port A.	A
Lock on Port b.	B
Lock on both ports.	C

Special	
	M
	O
	O

Special	
Spring centred from P to A. Opposite end detented.	J
2 Detent Stop in end lever cap	E
Sprung P to B. Stop in end lever cap.	B

← Hose rewind valve

Example	BG4D	–	081	–	C	E	A	C

BG4D 1/2” BSPP

Cam Operated Directional Control Valve

Description

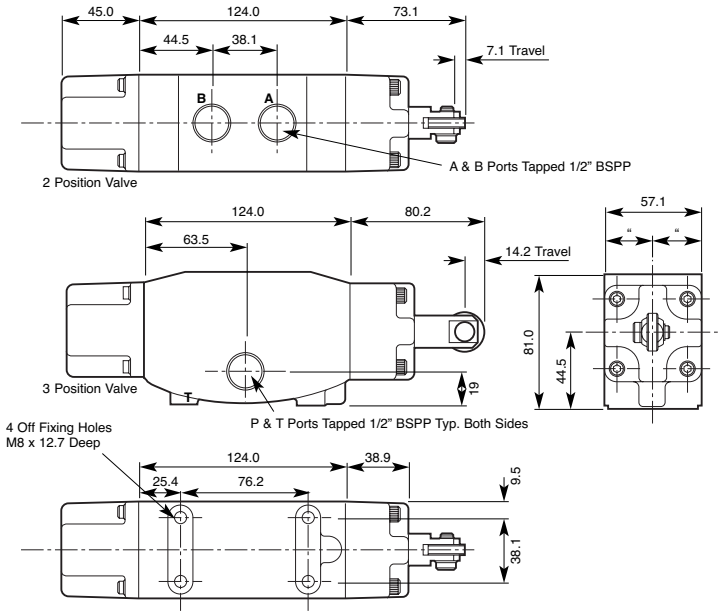
- Nominal flow rate - 55 lpm (see graph for further details)
- Max. operating pressure - 350 bar
- Max. pressure on ‘T’ port - 350 bar
- Recommended operating viscosity range - min. 13 c/st - max 800 c/st
- Recommended operating Temp. min. -30°C - max 80°C
- Recommended filtration - 25 microns or better
- Seals medium nitrile (consult Technical Sales for alternatives)
- Leakage - typical max. allowable on works test 15cc at 135 bar, oil 35 c/st at 40°C
- Mounting unrestricted

Directional functions

- N.B. Cam actuator fitted on ‘A’ port end
- Cam spring offset ‘P’ to ‘B’
- Cam depressed ‘P’ to ‘A’
- Force required to depress Cam start - 11.5 kg, Full - 36 kg

General Arrangement

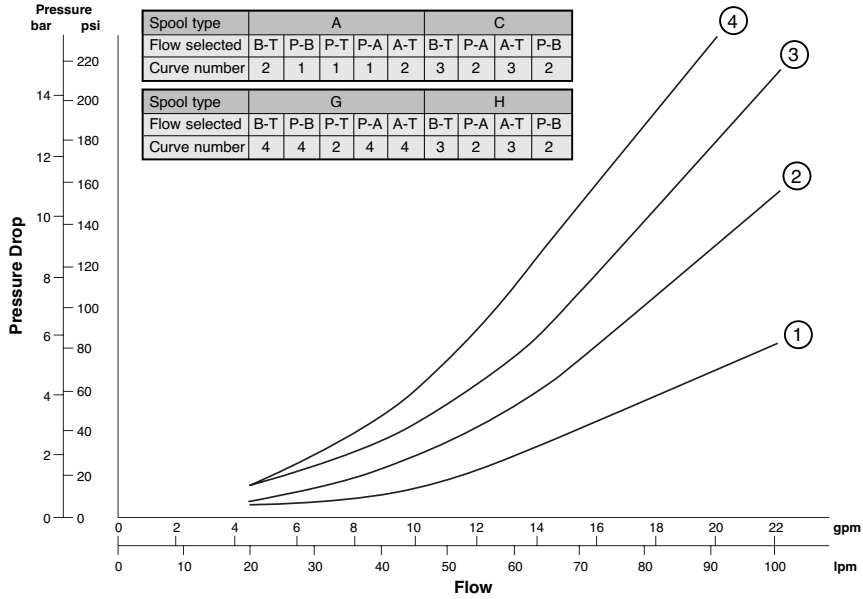
Weight 4.7kg



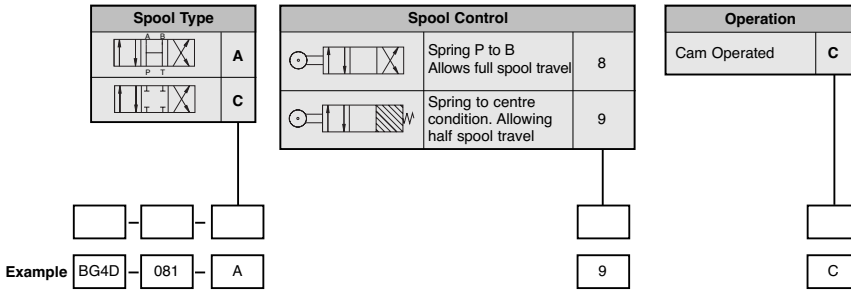
Pressure Drop Curve

Spool type	A					C			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	2	1	1	1	2	3	2	3	2

Spool type	G					H			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	4	4	2	4	4	3	2	3	2



Ordering Code



BG4D 1/2” BSPP

Air Pilot Operated Directional Control Valve

Description

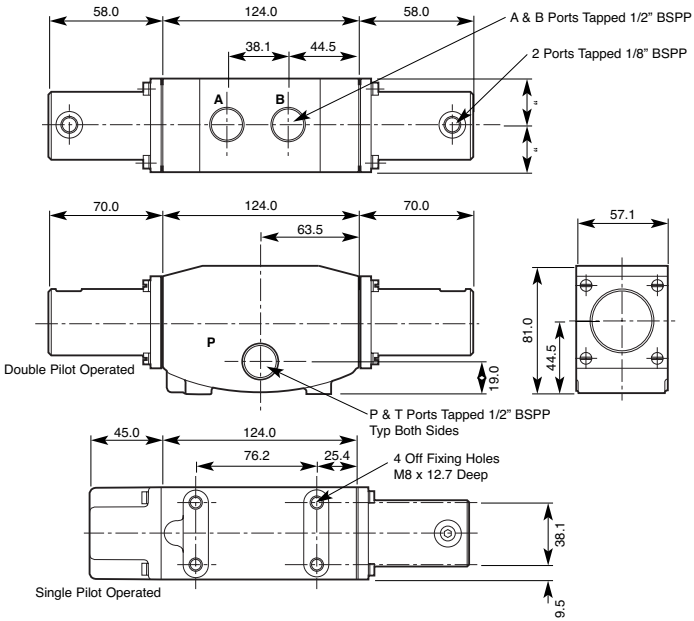
- Nominal flow rate - 55 lpm (see graph for further details)
- Max. operating pressure - 350 bar
- Max. pressure on “T” port - 350 bar
- Recommended operating viscosity range - min. 13 c/st - max. 800 c/st
- Recommended operating temperatures - min. -30°C - max. 80°C
- Recommended filtration - 25 microns or better
- Seals medium nitrile (consult Technical Sales for alternatives)
- Leakage - typical max. allowable on works test 15cc at 135 bar, oil 35 c/st at 40°C

Directional functions

- Air signal applied to port ‘A’ end - ‘P’ to ‘A’
- Air signal applied to port ‘B’ end - ‘P’ to ‘B’
- Air pilot operating pressure - min. 5 bar, max. 10 bar
- Air actuator volume 15 cc

General Arrangement

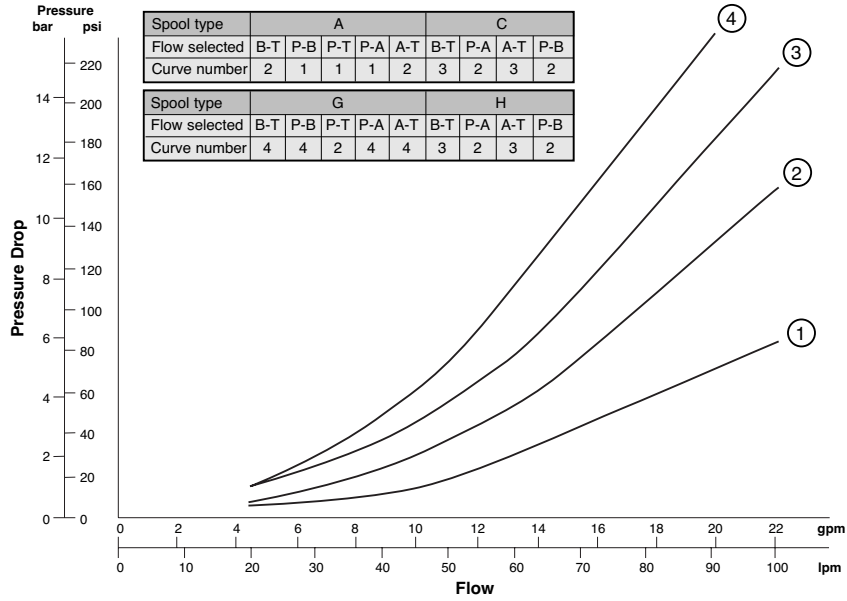
Weight 4.1 kg



Pressure Drop Curve

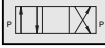
Spool type	A					C			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	2	1	1	1	2	3	2	3	2

Spool type	G					H			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	4	4	2	4	4	3	2	3	2



Ordering Code

Spool Type	
	A
	C
	G
	H

Spool Control	
 Spring Centred	4
 Spring Offset P to B	6
 Springless	7

Operation	
Double Air Pilot Spool control 4 only	P
Single Air Pilot Spool control 4, 6	O
Springless double Air Pilot	Q

Pilot Operated Service Port Lock Addition A or H Spools Only	
Lock on Port A	A
Lock on Port B	B
Lock on Both Ports	C

Example	BG4D	–	081	–	G		7		Q		A

BG4D 1/2” BSPP

Oil Pilot Operated Directional Control Valve

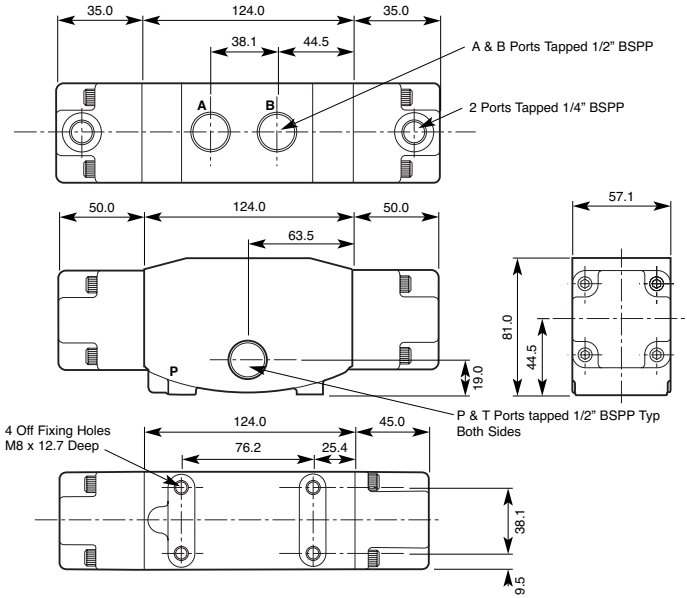
Description

- Nominal flow rate - 55 lpm (see graph for further details)
- Max. operating pressure - 350 bar
- Max. pressure on “T” port - 350 bar
- Recommended operating viscosity range - min. 13 c/st - max. 800 c/st
- Recommended operating temperatures - min. -30°C - max. 80°C
- Recommended filtration - 25 microns or better
- Seals medium nitrile (consult Technical Sales for alternatives)
- Leakage - typical max. allowable on works test 15cc at 135 bar, oil 35 c/st at 40°C
- Mounting unrestricted

Directional functions

- Air signal applied to port ‘A’ end - ‘P’ to ‘A’
- Air signal applied to port ‘B’ end - ‘P’ to ‘B’
- Pilot operating pressure - min. 10 bar, max. 135 bar
- Pilot volume 7.5cc

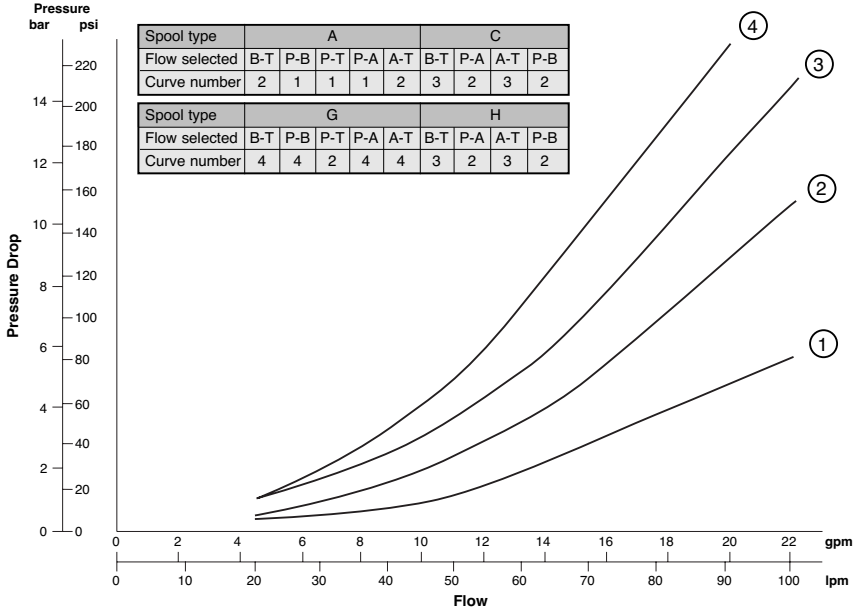
General Arrangement



Pressure Drop Curve

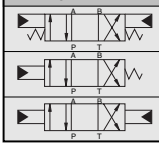
Spool type	A					C			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	2	1	1	1	2	3	2	3	2

Spool type	G					H			
Flow selected	B-T	P-B	P-T	P-A	A-T	B-T	P-A	A-T	P-B
Curve number	4	4	2	4	4	3	2	3	2



Ordering Code

Spool Type	
Open Centre	A
Closed Centre	C
Tandem Centre	G
Float Centre	H

Spool Control	
	4
	6
	7

Operation	
Double Oil Pilot Spool control 4 only	D
Single Oil Pilot Spool control 4, 6	N
Springless Double Oil Pilot	L

Pilot Operated Service Port Lock Addition A or H Spools Only	
Lock on Port A	A
Lock on Port B	B
Lock on Both Ports	C

Example	BG4D	081	H	6	L	B

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Section 4

Hydraulic Relief Valves

RV 020

Direct In-line Relief Valve

Pressure Relief Valves limit the maximum working pressure of a hydraulic system to a pre-determined rating thus providing protection against the overloading of system components.

Direct acting relief valves unload flow to tank when system pressure is sufficient to compress a spring which unseats a poppet. They have a high tolerance to contamination and are generally used for low flow rates where precise pressure control is not critical.

Specifications

Maximum Pressure:
210 bar

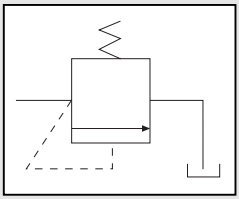
Maximum Flow:
20 lpm

Porting:
See Table 1, ordering codes

Material:
Steel components in High Tensile Aluminium body

Weight:
0.060 kg

Symbol



Features

- Direct acting in-line relief valve giving high tolerance to particle contamination.
- Quick response provides protection against shock loads.
- Relief pressure is factory set to customer requirements within a range between 20 - 210 bar.
- Straight through porting allows the valve to be connected directly in-line with a T piece thus making the best use of restricted space.
- Provides protection against thermal expansion of fluids.

Ordering Codes

Typical Code RV020 150 J A

RV020 - Valve Type

Relief Pressure Setting in bar between 20 - 210 bar

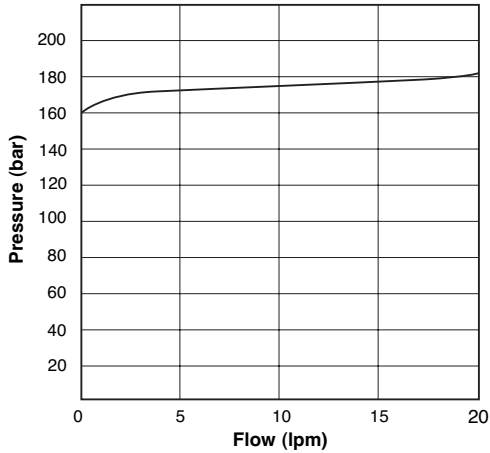
Porting (Table 1)

A - Design Standard

Table 1: Inlet Porting

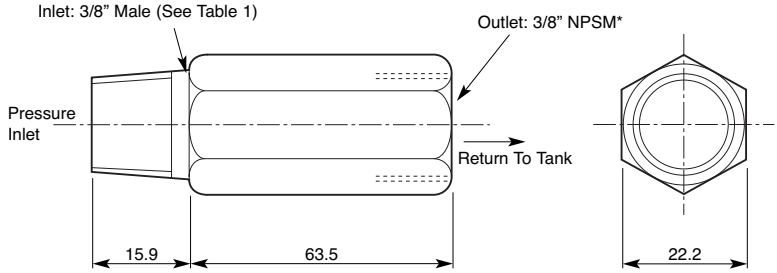
Code	Inlet Port Threads
A	$^3/_8$" NPTF
J	$^3/_8$" BSPP

Typical Characteristics
(at one pressure setting)



Curve established using hydraulic mineral oil with viscosity of 27.4 centistokes at 49°C

Installation Details
Dimensions in millimetres



* National pipe straight mechanical.

RV 050

Pressure Relief Valve

Pressure Relief Valves limit the maximum working pressure of a hydraulic system to a pre-determined rating thus providing protection against the overloading of system components.

Direct acting relief valves unload flow to tank when system pressure is sufficient to compress a spring which unseats a poppet. They provide high tolerance to contamination and are generally used for low flow rates where precise pressure control is not critical.

Specifications

Maximum Pressure:
210 bar

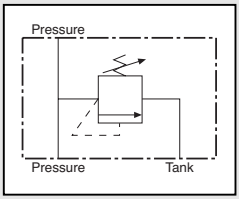
Maximum Flow:
50 lpm

Porting:
See Table 2, ordering codes

Material:
Steel components in high tensile aluminium body

Weight:
0.5 kg

Symbol



Features

- Direct acting, in-line relief valve giving high tolerance to contamination.
- Quick response provides protection against shock loads.
- Relief pressure is adjustable by means of a screw and locknut. See Table 1, ordering codes for available adjustment ranges.
- Provides protection against thermal expansion of fluid.
- Can be used as a remote control for a pilot operated relief valve by substituting for the built in direct acting relief valve of the pilot operated valve.
- Flow through pressure ports enable the valve to be connected in-line with mounting versatility and convenience.

Ordering Codes

Typical Code RV050 1 J S

RV050 - Valve Type

Adjustment Range (Table 1)

Porting (Table 2)

Adjustment Method (Table 3)

Table 1: Adjustment Range

Code	Port Threads
1	10 - 103 bar
2	14 - 210 bar

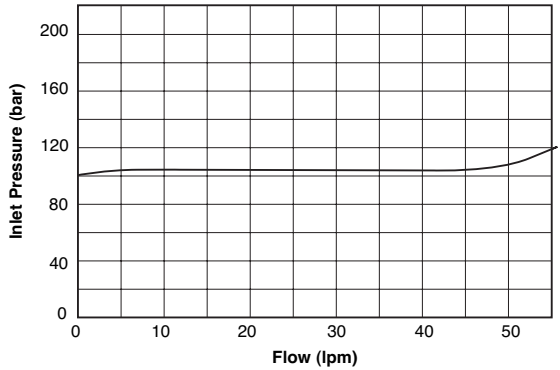
Table 2: Porting

Code	Port Thread
I	$^{3}/_{4}$" -16UN #8 SAE ORB
J	$^{1}/_{2}$" BSPP

Table 3: Adjustment Method

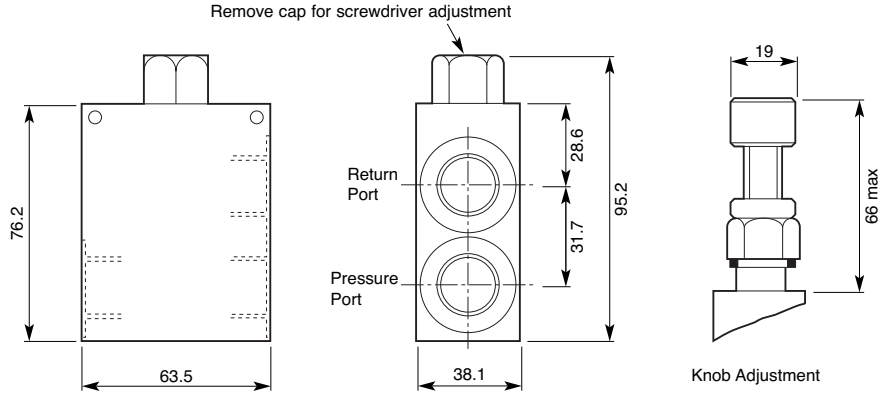
Code	Adjustment
S	Screwdriver
K	Knob

Typical Characteristics
(at one Pressure Setting)



Curve established using hydraulic mineral oil with viscosity of 27.4 centistokes 49°C

Installation Details
Dimensions in Millimetres



RV 5

Pressure Relief Valve

Pressure Relief Valves limit the maximum working pressure of a hydraulic system to a pre-determined rating thus providing protection against the overloading of system components.

Direct acting relief valves unload flow to tank when system pressure is sufficient to compress a spring which unseats a poppet. They have a high tolerance to contamination and are generally used for low flow rates where precise pressure control is not critical.

Specifications

Maximum Pressure:
276 bar

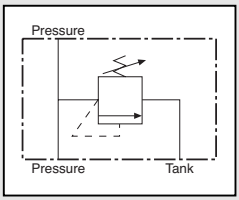
Maximum Flow:
70 lpm

Porting:
3/4" BSPP

Material:
Steel cartridge in high tensile aluminium body.

Weight:
0.75 kg

Symbol



Features

- Direct acting in-line relief valve giving high tolerance to contamination.
- Quick response provides protection against shock loads.
- Provides protection against thermal expansion of fluid.
- Can be used as a remote control for a pilot operated relief valve by substituting for the built in direct acting relief valve of the pilot operated valve.
- Flow through pressure ports enable the valve to be connected in-line with mounting versatility and convenience.

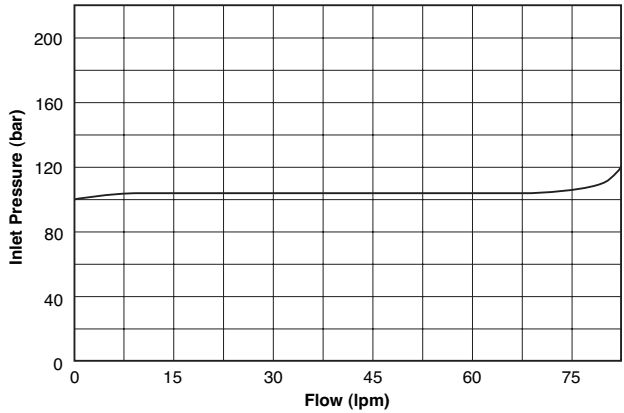
Ordering Codes

Typical Code RV5 120

RV5 - Valve Type

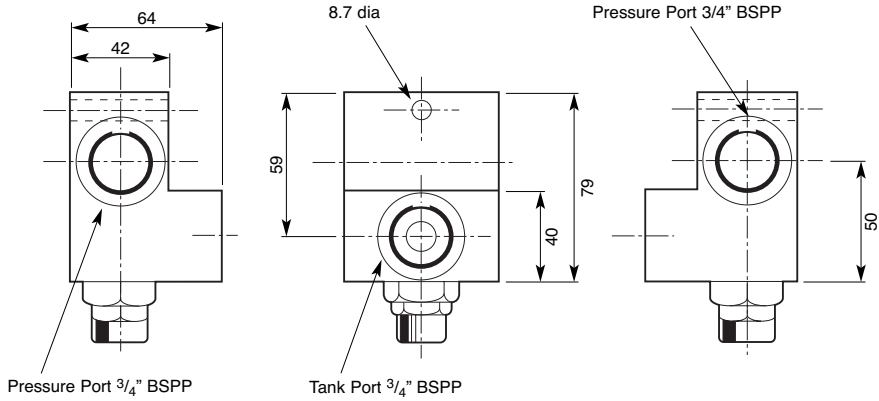
Pressure Setting in bar between100 - 276 bar

Typical Characteristics
(at one Pressure Setting)



Curve established using hydraulic mineral oil with viscosity of 27.4 centistokes at 49°C

Installation Details
Dimensions in millimetres



RV 125

Pressure Relief Valve

Pressure Relief Valves limit the maximum working pressure of a hydraulic system to a pre-determined rating thus providing protection against the overloading of system components.

Direct acting relief valves unload flow to tank when system pressure is sufficient to compress a spring which unseats a poppet. Pilot operated valves have a built-in direct acting relief valve which, when opened by system pressure, causes a larger spool to move permitting larger flow rates to return to tank. Pilot operated relief valves provide more precise pressure control than direct acting valves.

Specifications

Maximum Pressure:
210 bar

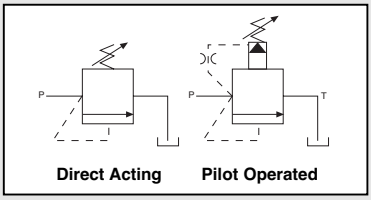
Maximum Flow:
125 lpm

Porting:
See Table 2, ordering codes

Material:
Steel components in high tensile aluminium body.

Weight:
1.05 kg

Symbol



Direct Acting **Pilot Operated**

Features

- Cartridges are available providing either direct acting for high tolerance to particular contamination or pilot operation for quiet, smooth and accurate pressure control.
- Relief pressure is adjustable from 80 - 210 bar by means of a screw concealed by a cap unit.
- A gauge port is provided for the convenience of the user.
- Flow through pressure ports enable the valve to be connected in-line with mounting versatility and convenience without causing restriction.

Ordering Codes

Typical Code RV125 PO J 100

RV125 - Valve Type

Cartridge Type (Table 1)

Porting (Table 2)

Pressure setting in bar between 80 - 210 bar

Table 1: Cartridge Type

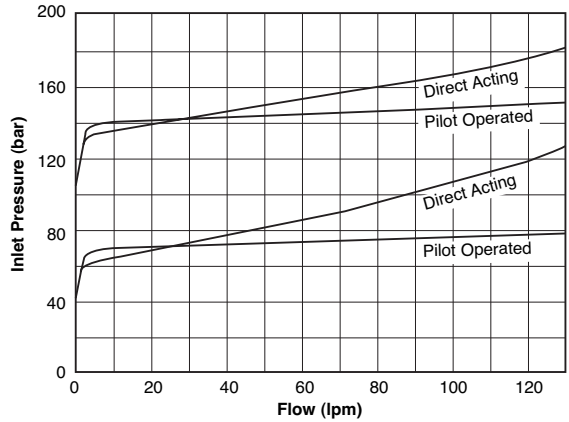
Code	Description
PO	Pilot Operated Cartridge
DA	Direct Acting Cartridge

Table 2: Porting

Code	Description
J	$^{3}/_{4}$" BSPP
G	1-$^{1}/_{16}$" -12UN #12 SAE ORB

Typical Characteristics

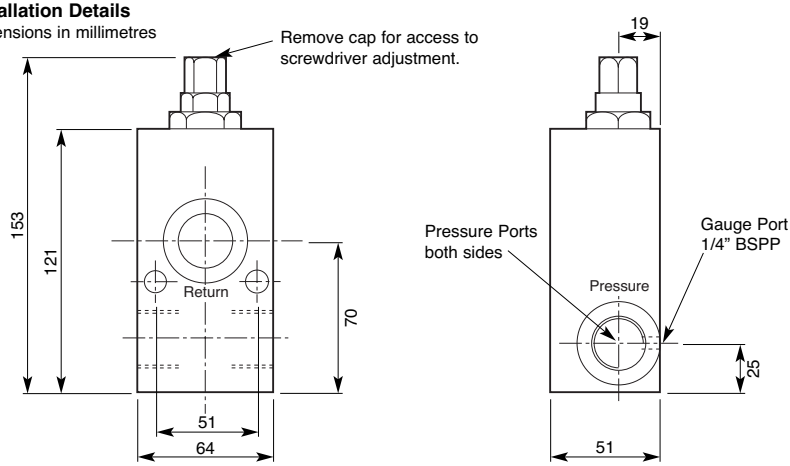
(at two pressure settings for both a direct acting and a pilot operated cartridge)



Curve established using hydraulic mineral oil with viscosity of 27.4 centistokes at 49°C

Installation Details

Dimensions in millimetres



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Section 5

Technical Information

Imperial

Hydraulic Motor or Engine Torque

$$T = \frac{5252 \times HP}{rpm}$$

Where: T = Torque in pounds feet
HP = Horsepower
rpm = Engine speed in revolutions per minute

Example: What is the torque of an engine that develops 40 HP at 2500 rpm?

$$T = \frac{5252 \times 40}{2500} = 84 \text{ lbs - feet}$$

Axle Torque

The torque available at the driving axle is the hydraulic motor torque multiplied by gear reduction through the transmission and axle.

Where Ta = T x Rta x Ra
Ta = Axle torque (lb in)
Ra = Axle gear reduction
Rta = Gear reduction through auxiliary transmission if used
T = Motor torque (lb in)

Example: What is the rear axle torque in high gear on a vehicle having 1000 lb in motor torque, an auxiliary ratio of 4:1, and an axle ratio of 20:1.

Ta = 1000 x 4 x 20 = 80,000 lb in.

Hydraulic Motor Torque Required

The torque required to slip the wheels is the vehicle weight over the driving tyres times the coefficient of friction of the driving tyres on rolling surface times the rolling radius of tyres divided by the overall gear reduction.

$$ST = \frac{VW \times u \times r}{R}$$

Where VW: = Vehicle weight over driving tyres VW (lbs)
u = Coefficient of friction of tyres on average road surface, generally 0.6.
T = Rolling radius of loaded driving tyre in inches.
R = Overall gear reduction in both axle and transmission.

Metric

Hydraulic Motor or Engine Torque

$$T = \frac{9.545 \times P}{rpm}$$

Where: T = Torque in newton metre (N m)
P = Power in watts (W)
rpm = Engine speed in revolutions per minute

Example: What is the torque of an engine that develops 30,000w at 2500 rpm?

$$T = \frac{9.545 \times 30{,}000}{2500} \quad 114.54 \text{ N-m}$$

Axle Torque

The torque available at the driving axle is the hydraulic motor torque multiplied by gear reduction through the transmission and axle.

Where Ta = T x Rta x Ra
Ta = Axle torque (N m)
Ra = Axle gear reduction
Rta = Gear reduction through auxiliary transmission if used
T = Motor torque (N m)

Example: What is the rear axle torque in high gear on a vehicle having 100 Nm in motor torque, an auxiliary ratio of 5:1, and an axle ratio of 20:1.

Ta = 100 x 5 x 20 = 10,000 N m.

Hydraulic Motor Torque Required

The torque required to slip the wheels is the vehicle weight over the driving tyres times the coefficient of friction of the driving tyres on rolling surface times the rolling radius of tyres divided by the overall gear reduction.

$$ST = \frac{VW \times u \times r}{R \times 101.97}$$

Where VW: = Vehicle weight over driving tyres VW (kg)
u = Coefficient of friction of tyres on average road surface, generally 0.6.
r = Rolling radius of loaded driving tyre in millimetres.
R = Overall gear reduction in both axle and transmission.

Imperial

Hydraulic Motor Torque To Slip Wheels

Example: What is the motor torque required to slip wheels of a vehicle where the weight over he driving tyre is 2000lb, the coefficient of friction of the tyres is 0.6., the rolling radius is 15 inches. The total reduction of power train is 10.

$$ST = \frac{2000 \times .6 \times 15}{10} \quad 1800 \text{ lb in}$$

Hydraulic Motor Speed From mph

The motor speed is obtained by multiplying 168 by the ratio of the power train by the miles per hour and diving this sum by the rolling radius of the tyre.

$$rpm = \frac{168 \times R \times mph}{r}$$

168	=	Factor
rpm	=	Revolutions per minute of engine
r	=	Rolling radius of loaded drive tyre in inches
R	=	Overall gear reduction including both axle and transmission
mph	=	Vehicle speed in miles per hour

Example: Find the motor speed where the overall gear reduction is 10, vehicle speed is 15 mph and rolling radius of driving tyre is 15 inches. 1680 rpm

$$rpm = \frac{168 \times 10 \times 15}{15} = 1680 \text{ rpm}$$

Miles Per Hour From Motor Speed

Vehicles speed in miles per hour is the rolling radius of loaded driving tyre multiplied by the motor rpm and divided by 168 times the overall gear reduction of the power train.

$$mph = \frac{rpm \times r}{168 \times R}$$

168	=	Factor
rpm	=	Revolutions per minute of the motor
r	=	Rolling radius of loaded driving tyre in inches
R	=	Overall gear reduction including both axle and transmission
mph	=	Vehicle speed in miles per hour

Example: Find the mph of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 15 inches and the overall gear reduction is 10.

$$mph = \frac{1680 \times 15}{168 \times 10} = 15 \text{ mph}$$

Metric

Hydraulic Motor Torque To Slip Wheels

Example: What is the motor torque required to slip wheels of a vehicle where the weight over the driving tyre is 1000 kg, the coefficient of friction of the tyres is 0.6., the rolling radius is 400 mm. The total reduction of power train is 10.

$$ST = \frac{1000 \times 0.6 \times 400}{10 \times 101.97} \quad 235.36 \text{ Nm}$$

Hydraulic Motor Speed From kph

The motor speed is obtained by multiplying 2651.51 by the ratio of the power train by the kilometres per hour and dividing this sum by the rolling radius of the tyre.

$$rpm = \frac{2651.51 \times R \times kph}{r}$$

2651.51	=	Factor
rpm	=	Revolutions per minute of engine
r	=	Rolling radius of loaded drive tyre in millimetres
R	=	Overall gear reduction including both axle and transmission
mph	=	Vehicle speed in kilometres per hour

Example: Find the motor speed where the overall gear reduction is 10, vehicle speed is 20 kph and rolling radius of driving tyre is 400 millimetres.

$$rpm = \frac{2651.51 \times 10 \times 20}{400} \quad 1325.75 \text{ rpm}$$

Kilometres Per Hour From Motor Speed

Vehicles speed in kilometres per hour is the rolling radius of loaded driving tyre multiplied by the motor rpm and divided by 2651.51 times the overall gear reduction of the power train.

$$kph = \frac{rpm \times r}{2651.51 \times R}$$

2651.51	=	Factor
rpm	=	Revolutions per minute of the motor
r	=	Rolling radius of loaded driving tyre in millimetres
R	=	Overall gear reduction including both axle and transmission
kph	=	Vehicle speed in kilometres per hour

Example: Find the kph of a vehicle where the motor speed is 1326 rpm, the rolling radius of loaded driving tyre is 400 millimetres and the overall gear reduction is 10.

$$KPH = \frac{1326 \times 400}{2651.51 \times 10} = 20 \text{ kph}$$

Imperial

Tractive Effort

The tractive effort is obtained by multiplying the torque by the total ratio of power train and dividing this sum by the rolling radius of the driving tyres.

$$TE = \frac{T \times R}{r}$$

Where: T = Motor torque in lb. in.
R = Overall gear reduction including both axle and transmission.
r = Rolling radius of loaded driving tyre in inches.

Example: Find the tractive effort where the rolling radius of driving tyres is 15 inches, the total ratio of power train is 10, the motor torque is 1000 lb in.

$$TE = \frac{1000 \times 10}{15} \; 667$$

Overall Gear Reduction

The overall gear reduction is the rpm times the rolling radius of the loaded driving tyre divided by 168 times the vehicle speed in miles per hour.

$$R = \frac{rpm \times r}{168 \times mph}$$

168 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded driving tyre in inches
R = Overall gear reduction including both axle and transmission
mph = Vehicle speed in miles per hour

Example: Find out overall gear reduction of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 15 inches and the mph is 15.

$$R = \frac{1680 \times 15}{168 \times 15} \; 10 \text{ to } 1$$

Metric

Tractive Effort

The tractive effort is obtained by multiplying the torque by the total ratio of power train and dividing this sum by the rolling radius of the driving tyres.

$$TE = \frac{T \times R \times 1000}{r}$$

Where: T = Motor torque in lb in.
R = Overall gear reduction including both axle and transmission.
r = Rolling radius of loaded driving tyre in millimeters.

Example: Find the tractive effort where the rolling radius of driving tyres is 400 millimetres, the total ratio of power train is 10, the motor torque is 115 Nm.

$$TE = \frac{115 \times 10 \times 1000}{400} = 2875 \text{ N}$$

Overall Gear Reduction

The overall gear reduction is the rpm times the rolling radius of the loaded driving tyre divided by 2651.51 times the vehicle speed in kilometres per hour.

$$R = \frac{rpm \times r}{2651.51 \times kph}$$

2651.51 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded driving tyre in millimetres
R = Overall gear reduction including both axle and transmission
kph = Vehicle speed in kilometres per hour

Example: Find out overall gear reduction of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 381mm and the kph is 24.

$$R = \frac{1680 \times 381}{2651.51 \times 24} \; 10 \text{ to } 1$$

Imperial

Rolling Radius Of Loaded Driving Tyre

The rolling radius of loaded driving tyre is 168 times the overall gear reduction times the miles per hour divided by the engine speed.

$$r = \frac{168 \times R \text{ mph}}{\text{rpm}}$$

168	=	Factor
rpm	=	Revolutions per minute of the motor
r	=	Rolling radius of loaded driving tyres in inches
R	=	Overall gear reduction including both axle and transmission
mph	=	Vehicle speed in miles per hour

Example: Find the rolling radius of loaded driving tyre of a vehicle where the overall gear reduction is 10, the miles per hour 15 and the engine speed 1680 rpm.

$$r = \frac{168 \times 10 \times 15}{1680} = 15 \text{ inches}$$

Road Rolling Resistance

The road rolling resistance is the force required to push a vehicle over the surface it is rolling over and maybe expressed in several ways. One, in terms of pounds resistance per thousand pounds of gross weight. Other methods are derived from this basic expression. Following is a table of rolling resistance in pounds per thousand pounds of gross weight for various road surfaces.

Rolling resistance is the gross vehicle weight in lbs, times the rolling resistance of the surface divided by 1000.

$$RR = \frac{GVW \times R}{1000}$$

Where: RR	=	Road rolling resistance in pounds
GVW	=	Gross vehicle weight in pounds
R	=	Rolling resistance in pounds per thousand pounds vehicle weight
1000	=	A constant to determine number of thousand pounds in vehicle

Example: What is the rolling resistance of a vehicle with a gross weight of 10,000 pounds on poor asphalt

$$RR = \frac{10{,}000 \times 22}{1000} = 220 \text{ lbs}$$

Many formula are arranged to use the rolling resistance in the table below as a factor. To set the table data up in factor form divide the resistance in lbs by 1000.

Metric

Rolling Radius Of Loaded Driving Tyre

The rolling radius of loaded driving tyre is 2651.51 times the overall gear reduction times the kilometres per hour divided by the engine speed.

$$r = \frac{2651.51 \times R \times \text{kph}}{\text{rpm}}$$

2651.51	=	Factor
rpm	=	Revolutions per minute of the motor
r	=	Rolling radius of loaded driving tyres in millimetres
R	=	Overall gear reduction including both axle and transmission
kph	=	Vehicle speed in kilometers per hour

Example: Find the rolling radius of loaded driving tyre of a vehicle where the overall gear reduction is 10, the kilometres per hour 20 and the engine speed 1500 rpm.

$$r = \frac{2651.51 \times 10 \times 20}{1500} = 353.5 \text{ mm}$$

Road Rolling Resistance

The road rolling resistance is the force required to push a vehicle over the surface it is rolling over a maybe expressed in several ways. One, in terms of newtons resistance per hundred kilograms of gross weight. Other methods are derived from this basic expression. Following is a table of rolling resistance in pounds per thousand pounds of gross weight for various road surfaces.

Rolling resistance in Newton per hundred kilograms is the gross vehicle weight in kg, times the rolling resistance of the surface divided by 100.

$$RR = \frac{GVW \times R}{100}$$

Where: RR	=	Road rolling resistance in newtons
GVW	=	Gross vehicle weight in kilograms
R	=	Rolling resistance in newtons per hundred kilograms vehicle weight
100	=	A constant to determine number of 100 kg in vehicle

Example: What is the rolling resistance of a vehicle with a gross weight of 4,500 kg on poor asphalt

$$RR = \frac{4{,}500 \times 22}{100} = 990 \text{ lbs}$$

Many formula are arranged to use the rolling resistance in the table below as a factor. To set the table data up in factor form divide the resistance in N by 100

Imperial

$$Q = \frac{R}{1000}$$

Where: Q = Rolling resistance factor per pound of gross vehicle weight.
R = Rolling resistance in pounds per thousand pounds vehicle weight.

Example: What is the rolling resistance factor per pound of gross vehicle weight on poor concrete?

$$Q = \frac{20}{1000} = .02$$

Another method of expressing road rolling resistance is percent of grade. To express rolling resistance in percent of grade multiply rolling resistance per thousand pounds vehicle by 100 and divide by 1000.

$$RR\% = \frac{R \times 100}{1000}$$

Where: RR% = Road rolling resistance in percent Grade of grade
R = Rolling resistance pounds per thousand pounds vehicle weight
100 = A constant to express percent.

Example: What is the road rolling resistance expressed in percent of grade of a vehicle on poor concrete?

$$RR\% = \frac{20 \times 100}{1000} = 2\%$$

Table Of Rolling Resistance In Pounds Per 1000 Pounds Of Gross Weight

Concrete, excellent	10 lbs
Concrete, good	15 lbs
Concrete, poor	20 lbs
Asphalt, good	12 lbs
Asphalt, fair	17 lbs
Asphalt, poor	22 lbs
Macadam, good	15 lbs
Macadam, fair	22 lbs
Macadam, poor	37 lbs
Cobbles, ordinary	55 lbs
Cobbles, poor	85 lbs
Snow, 2 inch	25 lbs
Snow, 4 inch	37 lbs
Dirt, smooth	25 lbs
Dirt, sandy	37 lbs
Mud	37 lbs to 150 lbs
Sand, level soft sand	60 lbs to 150 lbs
Sand, dune	160 lbs to 300 lbs

Metric

$$Q = \frac{R}{100}$$

Where: Q = Rolling resistance factor per kilogram of gross vehicle weight.
R R = Rolling resistance in newtons per hundred kilograms vehicle weight.

Example: What is the rolling resistance factor per kilogram of gross vehicle weight on poor concrete?

$$Q = \frac{20}{100} = .2$$

Another method of expressing road rolling resistance is percent of grade. To express rolling resistance in percent of grade multiply rolling resistance per hundred kilograms vehicle by 100 and divide by 1000.

$$RR\% = \frac{R \times 100}{1000}$$

Where: = Road rolling resistance in percent of RR% grade
R = Rolling resistance newtons per hundred kilograms vehicle weight
100 = A constant to express percent.
1000 = 100 x 10 (factor to account for discrepancy between newtons and kilograms).

Example: What is the road rolling resistance expressed in percent of grade of a vehicle on poor concrete?

$$RR\% = \frac{20 \times 100}{1000} = 2\%$$

Table Of Rolling Resistance In Newtons Per 100 Kilogram Of Gross Weight

Concrete, excellent	10 N
Concrete, good	15 N
Concrete, poor	20 N
Asphalt, good	12 N
Asphalt, fair	17 N
Asphalt, poor	22 N
Macadam, good	15 N
Macadam, fair	22 N
Macadam, poor	37 N
Cobbles, ordinary	55 N
Cobbles, poor	85 N
Snow, 2 inch	25 N
Snow, 4 inch	37 N
Dirt, smooth	25 N
Dirt, sandy	37 N
Mud	37 N to 150 N
Sand, level soft sand	60 N to 150 N
Sand, dune	160 N to 300 N

Imperial

Draw Bar Pull

The torque on the driving axle creates a force between the tyres and the road which is used to propel the vehicle. This gross force is termed the tractive effort and the net force, that is, gross force minus rolling resistance is the draw bar pull.

$$DP = \frac{T \times R}{r} - \frac{RR}{1000} \times GVW$$

Where: DP	=	Draw bar pull in lbs
T	=	Motor torque in lb in
R	=	Overall gear reduction including both axle and transmission
r	=	Rolling radius of loaded driving tyre in inches
RR	=	Road rolling resistance in pounds
GVW	=	Gross vehicle weight of motive vehicle in pounds

Example: What is the draw bar pull of a vehicle with a motor torque of 1000 lb in, an overall gear reduction of 10:1 and rolling radius of the driving tyre is 15 inches and a GVW of 10,000 lbs over good concrete?

$$DP = \frac{1000 \times 10}{15} - \frac{15}{1000} \times 10000 = 516 \text{ lbs}$$

Gradeability

Obviously, the tractive effort available at the wheels must be greater than the sum of the rolling resistance encountered. If this is not so, the transmission must be shifted to a lower gear in order to increase the tractive effort. The percentage of grade which can be negotiated is given by the formula.

$$G = \frac{100 \times T \times R}{r \times GVW} - RR$$

Where: 100	=	A constant expressing percentage grade and inches.
T	=	Motor torque in lb inches
R	=	Overall gear reduction including both axle and transmission
T	=	Rolling radius of loaded driving tyre in inches
GVW	=	Gross vehicle weight in pounds
RR	=	Rolling resistance expressed in percentage grade.

Example: What percentage grade can be negotiated by a vehicle having a hydraulic motor torque of 1000 lb inches, an overall gear reduction in high of 12 to 1, a tyre rolling radius of 15 inches and a gross vehicle weight of 10,000 lbs over good concrete.

$$G = \frac{100 \times 1000 \times 12}{15 \times 10{,}000} - 1.5\%$$

G = 8 - 1.5 = 6.5%

Metric

Draw Bar Pull

The torque on the driving axle creates a force between the tyres and the road which is used to propel the vehicle. This gross force is termed the tractive effort and the net force, that is, gross force minus rolling resistance is the draw bar pull.

$$DP = \frac{T \times R}{r} - \frac{RR}{100} \times GVW$$

Where: DP	=	Draw bar pull in newtons
T	=	Motor torque in newton metre's
R	=	Overall gear reduction including both axle and transmission
r	=	Rolling radius of loaded driving tyre in millimetres
RR	=	Road rolling resistance in newtons
GVW	=	Gross vehicle weight of motive vehicle in kilograms

Example: What is the draw bar pull of a vehicle with a motor torque of 115 N m, an overall gear reduction of 10:1 and rolling radius of the driving tyre is 400 millimetres and a GVW of 4,500 kilograms

$$DP = \frac{115 \times 10 \times 1000}{15} - \frac{15}{100} \times 4500 = 2200 \text{ N}$$

Gradeability

Obviously, the tractive effort available at the wheels must be greater than the sum of the rolling resistances encountered. If this is not so, the transmission must be shifted to a lower gear in order to increase the tractive effort. The percentage of grade which can be negotiated is given by the formula.

$$G = \frac{T \times R \times 10200}{r \times GVW} - RR$$

Where: 1000	=	Factor
T	=	Motor torque in newton metre's
R	=	Overall gear reduction including both axle and transmission
r	=	Rolling radius of loaded driving type in millimetres
GVW	=	Gross vehicle weight in kilograms
RR	=	Rolling resistance expressed percentage grade.

Example: What percentage grade can be negotiated by a vehicle having a hydraulic motor torque of 117 newton metre's, an overall gear reduction in high of 12 to 1, a tyre rolling radius of 400 mm and a gross vehicle weight of 4,500 kg over good concrete.

$$G = \frac{117 \times 121 \times 200}{400 \times 4500} - 1.5\ \%$$

G = 8 - 1.5 = 6.5%

Imperial

Grade Resistance

The grade resistance of a vehicle is .01 times the gross weight times the percentage grade.

GR = .01 x GVW x % grade
Where: GR = Grade resistance
GVW = Gross vehicle weight

Example: What is the grade resistance of a vehicle having a gross weight of 10,000 lbs. on a 5% grade?

GR = .01 x 10,000 x 5 = 500 lbs

Air Resistance

The air resistance against a vehicle is a force in lbs equal to .0025 times the miles per hour squared times the frontal area.

Where: AR = .0025 mph^2 x FA
AR = Air resistance in lbs
mph = Speed in miles per hour
FA = Frontal area of vehicle in sq. ft

Example: What is the air resistance of a vehicle travelling 40 miles per hour and having a frontal area of 80 square feet?

AR = .0025 x (40)2 x 80 = 320 lbs

Horsepower Required To Overcome Air Resistance

The horsepower required to overcome air resistance is the speed in miles per hour, cubed, times the frontal area in square feet divided by 150,000

$$HP = \frac{mph^3 \times FA}{150{,}000}$$

mph = Speed in miles per hour
FA = Frontal area in square feet
HP = Horsepower
150,000 = A conversion constant

Example: What is the horsepower required to overcome air resistance of a vehicle travelling 40 miles per hour and having a frontal area of 80 square feet?

$$HP = \frac{40^3 \times 80}{150{,}000} = 34.13$$

Metric

Grade Resistance

The grade resistance of a vehicle is 0.0981 times the gross weight times the percentage grade.

GR = 0.0981 x GVW x % grade
Where: GR = Grade resistance in newtons
GVW = Gross vehicle weight in kilograms

Example: What is the grade resistance of a vehicle having a gross weight of 4,500 kg. on a 5% grade?

GR = 0.0981 x 4,500 x 5 = 2207.25 N

Air Resistance

The air resistance against a vehicle is a force in newtons equal to 0.0462 times the kilometres per hour squared times the frontal area.

Where: AR = 0.0462 x kph^2 x FA
AR = Air resistance in newtons
kph = Speed in kilometres per hour
FA = Frontal area of vehicle in sq. metre's

Example: What is the air resistance of a vehicle travelling 65 kilometres per hour and having a frontal area of 7.5 m^2?

AR = 0.0462 x (65)2 x 7.5 = 1464 N

Horsepower Required To Overcome Air Resistance

The power required to overcome air resistance is the speed in kilometres per hour, cubed, times the frontal area in divided by 77.86

$$P = \frac{kph^3 \times FA}{77.86}$$

kph = Speed in kilometres per hour
FA = Frontal area in square meters
P = Power in watt
77.86 = A conversion factor

Example: What power is required to overcome air resistance of a vehicle travelling 65 kilometres per hour and having a frontal area of 7.5 m^2?

$$P = \frac{(65^3) \times 7.5}{77.86} = 26453.73 \text{ Watts}$$

Imperial

Ground Speed Of Track Laying Vehicle

The ground speed of a track laying vehicle is the hydraulic motor rpm times the circumference of the driving sprocket divided by 168 times 2 times 3.1416 times the overall gear reduction of the power train.

$$V = \frac{rpm \times C}{168 \times 2 \times 3.1416 \times R}$$

Where: V	=	Ground speed in mph
rpm	=	Rev. per min. of engine
C	=	Circumference
C	=	N x L
N	=	No. of teeth in sprocket
L	=	Length of links in inches
R	=	Overall gear reduction

Example: Find the ground speed in miles per hour where the motor speed is 1800 rpm, the number of teeth in the sprocket is 41, the length of link 8", and the total reduction of power train is 61 to 1.

C = 41 x 8 = 328

$$V = \frac{1800 \times 328}{168 \times 2 \times 3.1416} \times 61 = 9.169 \text{ mph}$$

Metric

Ground Speed Of Track Laying Vehicle

The ground speed of a track laying vehicle is the hydraulic motor rpm times the circumference of the driving sprocket divided by 16660 times the overall gear reduction of the power train.

$$V = \frac{rpm \times C}{16660 \times R}$$

Where: V	=	Ground speed in kph
rpm	=	Rev. per min. of engine
C	=	Circumference
C	=	N x L
N	=	No. of teeth in sprocket
L	=	Length of links in millimetres
R	=	Overall gear reduction

Example: Find the ground speed in kilometres per hour where the motor speed is 1800 rpm, the number of teeth in the sprocket is 41, the length of link 200 mm, and the total reduction of power train is 61 to 1.

C = 41 x 200 = 8200

$$V = \frac{1800 \times 8200}{16660 \times 61} = 14.524 \text{ kph}$$

Viscosity of Hydraulic Oil

The internal resistance to flow of a liquid is measured by a fluid is viscosity. More precisely absolute viscosity (μ) is defined in terms of the force between two parallel layers of fluid for a certain slip velocity between them.

This is represented by Newton ís equation ($\tau = \mu \frac{\partial u}{\partial y}$).

Very often a hydraulic fluid will be selected on the basis of its viscosity and the operating temperature of the system. A fluid will flow more easily the less viscous it is, since less energy is required to overcome the internal frictional forces. Any saving in energy must be balanced against an increase in leakage due to the lower fluid viscosity.

There are two measures of viscosity: absolute (also known as dynamic) and kinematic. The S.I. unit for absolute viscosity is N s m^{-2} or Pa.s. The non-S.I. unit is the poise (P) equivalent to 0.1 N s m^{-2} (not to be confused with the poiseuille (Pl), used in France, and equal to 10 poise) though the centipoise (cP) is more commonly used. In the hydraulics industry kinematic viscosity is more frequently used, where:

$$\text{kinematic viscosity} = \frac{\text{dynamic viscosity}}{\text{density}}$$

The S.I. unit for kinematic viscosity (ν) is $mm^2\ s^{-1}$ which corresponds to the older but still commonly used unit the centistoke (cSt).

Past measures of viscosity using arbitrary scales like Redwood No 1 seconds, Saybolt Universal Seconds (SUS), or degrees Engler should no longer be used. These units have been superseded by the empirical measures previously mentioned; conversion tables do exist but are only true at a fixed temperature.

Effect of temperature on viscosity

The temperature and viscosity of hydraulic oil are inversely related; as temperature increases, viscosity decreases. In order to define the kinematic viscosity of oil, its viscosity is quoted at a set temperature (40°C for the ISO standard) and the oil is given a value according to the viscosity index (V.I.). For example an oil quoted as conforming to ISO 22 will have a viscosity of 22 mm^2s^{-1}/ cSt at 40°C.

Viscosity Index

The viscosity index is a single number representation of the viscosity temperature characteristics of a fluid. The greater the value of the V.I. the smaller the change in viscosity for a given change in temperature, and vice-versa. Oils with a V.I. of 80 or more are said to have a high V.I. value. Oils with a V.I. between 80 and 40 are said to have a medium value and those below 40 a low value. Typically mineral oils used by the fluid power industry have a high V.I. of about 100. If temperature and kinematic viscosity are plotted to give a linear relationship (using logarithmic scales) then the V.I. is a measure of the gradient of the line. As the V.I. is increased the gradient is reduced. A typical temperature-viscosity curve for ISO oils can be seen opposite.

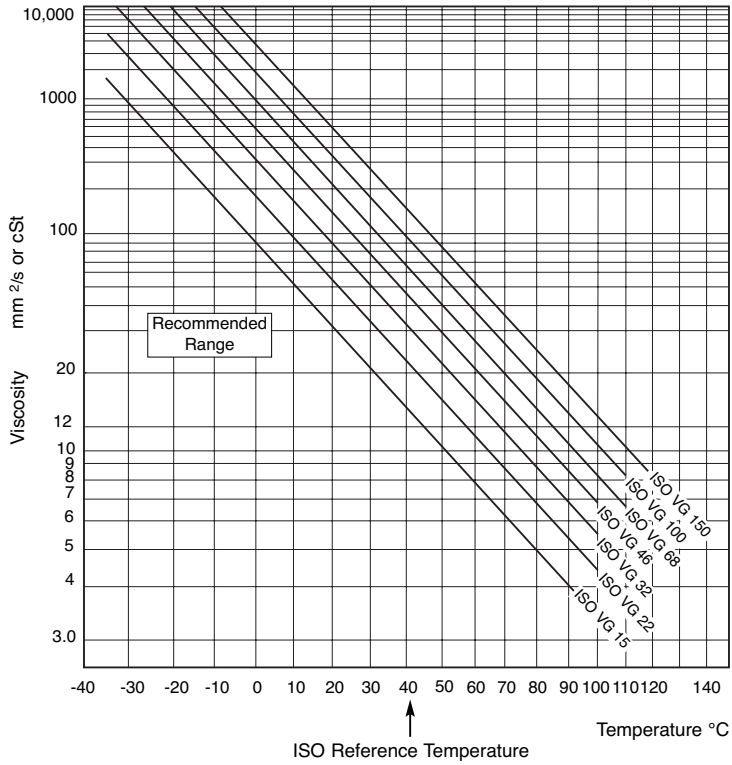
Effect of pressure on viscosity

Contrary to popular belief, varying pressure can lead to significant variations in viscosity. In a closed flow circuit at a fixed temperature, a change in pressure of 40 MPa (400 bar) can lead to a change of up to 8% in viscosity. However there are problems in calculating this variation.

Density and specific volume

The density of mineral oils is typically around 870kg m^{-3} (In comparison synthetic oils usually have a density of around 1200kg m^{-3}). The specific gravity, the ratio of the density of the fluid to the density of water, is a dimension less quantity typically 0.87 for mineral oils.

Graph of Temperature versus Kinematic Viscosity



Metric Conversion Factors

Symbols of SI units, multiples and submultiples are given in parentheses in the right hand column

Multiply	By	To Obtain
Length		
centimetre	0.03280840	foot
centimetre	0.3937008	inch
fathom	1.8288*	metre (m)
foot	0.3048*	metre (m)
foot	30.48*	centimetre (cm)
foot	304.8*	millimetres (mm)
inch	0.0254*	metre (m)
inch	2.54*	centimetre (cm)
inch	25.4*	millimetre (mm)
kilometre	0.6213712	mile (US statute)
metre	39.37008	inch
metre	0.5468066	fathom
metre	3.280840	foot
metre	0.1988388	rod
metre	1.093613	yard
metre	0.0006213712	mile (US statute)
microinch	0.0254*	micrometre (micron)(um)
Micrometre (Micron)	39.37008	microinch
mile (US statute)	1,609.344*	metre (m)
mile (US statute)	1.609.344*	kilometre (km)
millimetre	0.003280840	foot
millimetre	0.03937008	inch
rod	5.0292*	metre (m)
yard	0.9144*	metre (m)
Area		
acre	4046.856	metre^2 (m^2)
acre	0.4046856	hectare
centimetre^2	0.1550003	inch^2
centimetre^2	0.001076391	foot^2
foot^2	0.09290304*	metre$_2$ (m^2)
foot^2	929.0304*	centimetre$_2$ (cm^2)
foot^2	92,903.04*	millimetre$_2$ (mm^2)
hectare	2.471054	acre
inch^2	645.16*	millimetre$_2$ (mm^2)
inch^2	6.4516*	centimetre$_2$ (cm^2)
inch^2	0.00064516*	metre$_2$ (m^2)
metre^2	1,550.003	inch^2
metre^2	10.763910	foot^2
metre^2	1.195990	yard^2
metre^2	0.0002471054	acre
millimetre^2	0.00001076391	foot^2
millimetre^2	0.001550003	inch^2
yard^2	0.8361274	metre^2 (m^2)

*** Where an Asterisk is shown, the figure is exact.**

Multiply	By	To Obtain
Volume (including Capacity)		
centimetre^3	0.06102376	inch^3
foot^3	0.02831685	metre^3 (m^3)
foot^3	28.31685	litre
gallon (UK liquid)	0.004546092	metre^3 (m^3)
gallon (UK liquid)	4.546092	litre
gallon (US liquid)	0.003785412	metre^3 (m^3)
gallon (US liquid)	3.785412	litre
inch^3	16.387.06	millimetre^3 (mm^3)
inch^3	16.38706	centimetre^3 (cm^3)
inch^3	0.0000168706	metre^3 (m^3)
litre	0.001*	metre^3 (m^3)
litre	0.2199692	gallon (UK liquid)
litre	0.2641720	gallon (US liquid)
litre	0.03531466	foot^3
metre^3	219.9692	gallon (UK liquid)
metre^3	264.1720	gallon (US liquid)
metre^3	35.31466	foot^3
metre^3	1.307951	yard^3
metre^3	1000.	litre
metre^3	61.023.76	inch^3
millimetre^3	0.00006102376	inch^3
yard^3	0.7645549	metre^3 (m^3)
Velocity, Acceleration, and Flow		
centimetre/second	1.968504	foot/minute
centimetre/second	0.03280840	foot/second
centimetre/minute	0.3937008	inch/minute
foot/hour	0.00008466667	metre/second (m/s)
foot/hour	0.00508*	metre/minute
foot/hour	0.3048*	metre/hour
foot/minute	0.508*	centimetre/second
foot/minute	18.288*	metre/hour
foot/minute	0.3048*	metre/minute
foot/minute	0.00508*	metre/second (m/s)
foot/second	30.48*	centimetre/second
foot/second	18.288*	metre/minute
foot/second	0.3048	metre/second (m/s)
foot/second^2	0.3048*	metre/second^2 (m/s^2)
foot^3/minute	28.31685	litre/minute
foot^3/minute	0.0004719474	metre^3/second (m^3/s)
gallons/min (US liquid)	0.003785412	metre^3/minute
gallons/min (US liquid)	0.00006309020	metre^3/second (m^3/s)
gallons/min (US liquid)	0.06309020	litre/second
gallons/min (US liquid)	3.785412	litre/minute
gallons/min (US liquid)	0.004546092	metre^3/minute
gallons/min (US liquid)	0.00007576820	metre^3/second (m^3/s)
inch/minute	25.4*	millimetre/minute
inch/minute	2.54*	centimetre/minute
inch/minute	0.0254*	metre/minute
inch/second^3	0.0254*	metre/second^3 (m/s^3)

Multiply	By	To Obtain
Velocity, Acceleration and Flow (Continued)		
kilometre/hour	0.6213712	mile/hour (US statute)
litre/minute	0.03531466	foot^3/minute
litre/minute	0.2641720	gallons/min (US liquid)
litre/second	15.85032	gallons/min (US liquid)
mile/hour	1.609344*	kilometre/hour
millimetre/minute	0.03937008	inch/minute
metre/second	11,811.02	foot/hour
metre/second	196.8504	foot/minute
metre/second	3.280840	foot/second
metre/second^2	3.280840	foot/second^2
metre/second^2	39.37008	inch/second^2
metre/minute	3.280840	foot/minute
metre/minute	0.05468067	foot/second
metre/minute	39.37008	inch/minute
metre/hour	3.280840	foot/hour
metre/hour	0.05468067	foot/minute
metre^3/second	2118.880	foot^3/minute
metre^3/second	13,198.15	gallon/minute (UK liquid)
metre^3/second	15,850.32	gallon/minute (US liquid)
metre^3/minute	219.9692	gallon/minute (UK liquid)
metre^3/minute	264.1720	gallon/minute (US liquid)
Mass and Density		
grain(1/7000 lb avoirdupois	0.06479891	gram (g)
gram	15.43236	grain
gram	0.001*	kilogram (kg)
gram	0.03527397	ounce (avoirdupois)
gram	0.03215074	ounce (troy)
gram/centimetre^3	0.03612730	pound/inch^3
hundredweight (long)	50.80235	kilogram (kg)
hundredweight (short)	45.35924	kilogram (kg)
kilogram	1000.*	gram (g)
kilogram	35.27397	ounce (avoirdupois)
kilogram	32.15074	ounce (troy)
kilogram	2.204622	pound (avoirdupois)
kilogram	0.06852178	slug
kilogram	0.0009842064	ton (long)
kilogram	0.001102311	ton (short)
kilogram	0.001*	ton (metric)
kilogram	0.001*	tonne
kilogram	0.01968413	hundredweight (long)
kilogram	0.02204622	hundredweight (short)
kilogram/metre^3	0.06242797	pound/foot^3
kilogram/metre^3	0.01002242	pound/gallon (UK liquid)
kilogram/metre^3	0.008345400	pound/gallon (US liquid)
ounce (avoirdupois)	28.34952	gram (g)
ounce (avoirdupois)	0.02834952	kilogram (kg)
ounce (troy)	31.10348	gram (g)
ounce (troy)	0.03110348	kilogram (kg)
pound (avoirdupois)	0.4535924	kilogram (kg)
pound/foot^3	16.01846	kilogram/metre^3 (kg/m^3)

Multiply	By	To Obtain
Mass and Density (Continued)		
pound/inch^3	27.67990	gram/centimetre^3 (g/cm^3)
pound/gal (US liquid)	119.8264	kilogram/metre^3 (kg/m^3)
pound/gal (UK liquid)	99.77633	kilogram/metre^3 (kg/m^3)
slug	14.59390	kilogram (kg)
ton (long 2240 lb)	1.016.047	kilogram (kg)
ton (short 2000 lb)	907.1847	kilogram (kg)
ton (metric)	1,000.*	kilogram (kg)
tone	1,000.*	kilogram (kg)
Force and Force / Length		
Dyne	0.00001*	newton (N)
kilogram - force	9.806650*	newton (N)
kilopond	9.806650*	newton (N)
newton	0.1019716	kilogram - force
newton	0.1019716	kilopond
newton	0.2248089	pound - force
newton	100.000.*	dyne
newton	7.23301	poundal
newton	3.596942	ounce - force
newton/metre	0.005710148	pound/inch
newton/metre	0.06852178	pound/foot
ounce - force	0.2780139	newton (N)
pound - force	4.448222	newton (N)
poundal	0.1382550	newton (N)
pound/inch	175.1268	newton/metre (N/m)
pound/foot	14.59390	newton/metre (N/m)
Moment of Inertia and Section Modulus		
moment of inertia (kg.m^2)	23.73036	pound - foot^2
moment of inertia (kg.m^2)	3.417.171	pound - inch^2
moment of inertia (lb.ft^2)	0.042.14011	kilogram - metre^2 (kg.m^2)
moment of inertia (lb.inch^2)	0.0002926397	kilogram - metre^2 (kg.m^2)
moment of section (foot^4)	0.008630975	metre^4 (m^4)
moment of section (inch^4)	41.62314	centimetre^4
moment of section (metre^4)	115.8618	foot^4
moment of section (centimetre^4)	0.02402510	inch^4
section modulus (foot^3)	0.02831685	metre^3 (m^3)
section modulus (inch^3)	0.00001638706	metre^3 (m^3)
section modulus (metre^3)	35.31466	foot^3
section modulus (metre^3)	61,023.76	inch^3

Multiply	By	To Obtain
Bending Moment or Torque		
dyne - centimetre	0.0000001.*	newton - metre (N-m)
kilogram - metre	9.806650.*	newton - metre (N-m)
ounce - inch	7.061552	newton - millimetre
ounce - inch	0.007061552	newton - metre (N - m)
newton - metre	0.7375621	pound - foot
newton - metre	10,000,000.*	dyne - centimetre
newton - metre	0.1019716	kilogram - metre
newton - metre	141.6119	ounce - inch
newton - millimetre	0.1416119	ounce - inch
pound - foot	1.355818	newton - metre (N-m)
Momentum		
kilogram - metre/second	7.233011	pound - foot/second
kilogram - metre/second	86.79614	pound - inch/second
pound - foot/second	0.1382550	kilogram - metre/second (kg.m/s)
pound - inch/second	0.01152125	kilogram - metre/second (kg.m/s)
Energy and Work		
Btu (International Table)	1,055.056	joule (J)
Btu (mean)	1,055.87	joule (J)
calorie (mean)	4.19002	joule (J)
foot - pound	1.355818	joule (J)
foot - poundal	0.04214011	joule (J)
joule	0.0009478170	Btu (International table)
joule	0.0009470863	Btu (mean)
joule	0.2386623	calorie (mean)
joule	0.7375621	foot - pound
joule	23.73036	foot - poundal
joule	0.9998180	joule (International US)
joule	0.9999830	joule (US legal, 1948)
joule (International US)	1.000182	joule (J)
joule (US legal, 1948)	1.000017	joule (J)
joule	0002777778	watt - hour
watt - hour	3600.*	joule (J)

Multiply	By	To Obtain
Pressure and Stress		
atmosphere (14.6959 lb/inch^2)	101,325	pascal (Pa)
bar	100,000.*	pascal (Pa)
bar	14.50377	pounds/inch^2
bar	100,000.*	newton/metre^2 (N/m^2)
hectobar	0.6474898	ton (long)/inch^2
kilogram/centimetre^2	14.22334	pounds/inch^2
kilogram/metre^2	9.806650*	newton/metre^2 (N/m^2)
kilogram/metre^2	9.806650*	pascal (Pa)
kilogram/metre^2	0.2048161	pound/foot^2
kilonewton/metre^2	0.1450377	pound/inch^2
newton/centimetre^2	1.450377	pound/inch^2
newton/metre^2	0.00001*	bar
newton/metre^2	1.0*	pascal (Pa)
newton/metre^2	0.0001450377	pound/inch^2
newton/metre^2	0.1019716	kilogram/metre^2
newton/millimetre^2	145.0377	pound/inch^2
pascal	0.00000986923	atmosphere
pascal	0.00001*	bar
pascal	0.1019716	kilogram/metre^2
pascal	1.0*	newton/metre^2 (N/m^2)
pascal	0.02088543	pound/foot
pascal	0.0001450377	pound/inch^2
pound/foot^2	4.882429	kilogram/metre^2
pound/foot^2	47.88026	pascal (PA)
pound/inch^2	0.06894757	bar
pound/inch^2	0.07030697	kilogram/centimetre^2
pound/inch^2	0.6894757	newton/centimetre^2
pound/inch^2	6.894757	kilonewton/metre^2
pound/inch^2	6,894.757	newton/metre^2 (N/m^2)
pound/inch^2	0.006894757	newton/millimetre$_2$ (N/m^2)
pound/inch^2	6,894.757	pascal (Pa)
ton (long)/inch^2	1.544426	hectobar

Multiply	By	To Obtain
Power		
Btu/Hour (International Table)	0.2930711	watt (W)
foot-pound/hour	0.0003766161	watt (W)
foot-pound/minute	0.02259697	watt (W)
horsepower (550 ft-lb/s)	0.7456999	kilowatt (kW)
horsepower (500 ft-lb/s)	745.6999	watt (W)
horsepower (electric)	746.*	watt (W)
horsepower (metric)	735.499	watt (W)
horsepower (UK)	745.70	watt (W)
Kilowatt	1.341022	horsepower (550 ft - lb/s)
watt	2,655.224	foot-pound/hour
watt	44.25372	foot-pound/minute
watt	0.001341022	horsepower (550 ft-lb/s)
watt	0.001340483	horsepower (electric)
watt	0.001359621	horsepower (metric)
watt	0.001341022	horsepower (UK)
watt	3.412141	Btu/Hour (International Table)
Viscosity		
centipose	0.001*	pascal-second (Pa.s)
centistoke	0.000001*	metre^2/second (m^2 /s)
metre^2 /second	1,000,000.*	centistoke
metre^2 /second	10,000.*	stoke
pascal-second	1000.*	centipose
pascal-second	10.*	poise
poise	0.1*	pascal-second (Pa.s)
stoke	0.0001.*	metre^2 /second (m^2/s)
Temperature		
temperature Celsius, tC	temperature Kelvin,tK	tK = tC + 273.15
temperature Fahrenheit,tF	temperature Kelvin,tK	tK = tF + 459.67/1.8
temperature Celsius,tC	temperature Fahren,tF	tF = 1.8 tc + 32
temperature Fahrenheit,tF	temperature Celsius,tC	tC = tF - 32/1.8
temperature Kelvin,tK	temperature Celcius,tC	tC = tK - 273.15
temperature Kelvin,tK	temperature Fahren,tF	tF = 1.8 tK - 459.67
temperature Kelvin,tK	temperature Rankine,tR	tR = 9/5 tK
temperature Rankine tR	temperature Kelvin,tK	tK = 5/9 tR

Conversion Tables - Inches to Millimetres

Inches		mm	Inches		mm	Inches		mm	Inches		mm	Inches		mm
Frac	Dec		Frac	Dec		Frac	Dec		Frac	Dec		Frac	Dec	
	.0004	.01	17/64	.2656	6.747		.571	14.5	29/32	.9062	23.019	1.7/16	1.4375	36.513
	.004	.10		.2756	7	37/64	.578	14.684	59/64	.922	23.416		1.4567	37
	.01	.25	9/32	.281	7.144		.5906	15	15/16	.9375	23.813	1.15/32	1.469	37.306
1/64	.0156	.397		.2953	7.5	19/32	.594	15.081		.9449	24		1.4961	38
	.0197	.50	19/64	.297	7.541	39/64	.609	15.478	61/64	.953	24.209	1.1/2	1.500	38.100
	.0295	.75	5/16	.3125	7.938	5/8	.625	15.875	31/32	.969	24.606	1.17/32	1.531	38.894
1/32	.03125	.794		.315	8		.6299	16		.9843	25		1.5354	39
	.0394	1	21/64	.328	8.334	41/64	.6406	16.272	63/64	.9844	25.003	1.9/16	1.5625	39.688
3/64	.0469	1.191		.3346	8.5		.6496	16.5	1	1.000	25.400		1.5748	40
	.059	1.5	11/32	.344	8.731	21/32	.656	16.669		1.0236	26	1.19/32	1.594	40.481
1/16	.0625	1.588		.3543	9		.6693	17	1.1/32	1.0312	26.194		1.6142	41
5/64	.0781	1.984	23/64	.359	9.128	43/64	.672	17.066	1.1/16	1.0625	26.988	1.5/8	1.625	41.275
	.0787	2		.374	9.5	11/16	.6875	17.463		1.063	27		1.6535	42
3/32	.094	2.381	3/8	.375	9.525	45/64	.703	17.859	1.3/32	1.094	27.781	1.21/32	1.6562	42.069
	.0984	2.5	25/64	.391	9.922		.7087	18		1.1024	28	1.11/16	1.6875	42.863
7/64	.109	2.778		39.37	10	23.32	.719	18.256	1.1/8	1.125	28.575		1.6929	43
	.1181	3	13/32	.406	10.319		.7283	18.5		1.1417	29	1.23/32	1.719	43.656
1/8	.125	3.175		.4134	10.5	47/64	.734	18.653	15/32	1.156	29.369		1.7323	44
	.1378	3.5	27/64	.422	10.716		.7480	19		1.1811	30	1.3/4	1.750	44.450
9/64	.141	3.572		.4331	11	3/4	.750	19.050	1.3/16	1.1875	30.163		1.7717	45
5/32	.156	3.969	7/16	.4375	11.113	49/64	.7656	19.447	1.7/32	1.219	30.956	1.25/32	1.781	45.244
	.1575	4	29/64	.453	11.509	25/32	.781	19.844		1.2205	31		1.8110	46
11/64	.172	4.366	15/32	.469	11.906		.7874	20	1.1/4	1.250	31.750	1.13/16	1.8125	46.038
	.177	4.5		.4724	12	51/64	.797	20.241		1.2598	32	1.27/32	1.844	46.831
3/16	.1875	4.763	31/64	.484	12.303	13/14	.8125	20.638	19/32	1.281	32.504		1.8304	47
	.1969	5		.492	12.5		8268	21		1.2992	33	1 7/8	1.875	47.625
13/64	.203	5.159	1/2	.500	12.700	53/64	828	21.034	1.5/16	1.3125	33.338		1.8898	48
	.2165	5.5		.5118	13	27/32	.844	21.431		1.3386	34	1.29/32	1.9062	48.419
7/32	.219	5.556	33/64	.5156	13.097	55/64	.859	21.828	1.11/32	1.344	34.131		1.9291	49
15/64	.234	5.953	17/32	.531	13.494		.8661	22	1.3/8	1.375	34.925	1.15/16	1.9375	49.213
	.2362	6	35/64	.547	13.891	7/8	.875	22.225		1.3779	35		1.9685	50
1/4	.250	6.350		.5512	14	57/64	.8906	22.622	1.13/32	1.406	35.719	1.31/32	1.969	50.006
	.2559	6.5	9/16	.5625	14.288		.9055	23		1.4173	36	2	2.000	50.800

Important Thread Information

All NPTF threads are to ANSI B1.20.3 -1976 Class 1. As stated in the standard it is recommended that "sealing is accomplished by the means of a sealant applied to the thread". NPT fittings may also be used to connect to NPTF ports (also with a sealant applied to the thread). All hydraulic connections should be made by suitably trained personnel. For further information please see the standard or contact Webtec sales office.

Formula For	Word Formula	Formula
Fluid Pressure (In Pounds/Square Inch)	**Pressure** = **Force** (pounds) / **Unit Area** (Square Inches)	$P = \frac{F}{A}$ or psi $= \frac{F}{A}$
Cylinder Area (In Square Inches)	**Area** = π x **Radius**^{2} (Inches) = $\frac{\pi}{4}$ x **Diameter**^{2} (Inches)	$A = \pi r^2$ $A = \frac{\pi D^2}{4}$ or $A = 0.785\ D^2$
Cylinder Force (In Pounds, Push or Pull)	**Force** = **Pressure** (psi) x **Net Area** (Square Inches)	F = psi x A or F = PA
Cylinder Velocity or Speed (In Feet/Second)	**Velocity** = 277.4 x **Flow Rate** (gpm) IMP / 12 x 60 x **Net Area** (Square Inches)	$v = \frac{277.4}{720A}$ or $v = \frac{0.3852}{A}$
Cylinder Volume Capacity In Gallons of Fluid (Imp)	**Volume** = π x **Radius** ^{2} (Inches) x **Stroke** (Inches) / 277.4 = **Net Area** (Square Inches) x **Stroke** (inches) / 277.4	$V = \frac{\pi r^2 L}{277.4}$ $V = \frac{AL}{277.4}$
Cylinder Flow Rate In Gallons per minute (IMP)	**Flow Rate** = 12 x 60 x **Velocity** (feet/sec) x Net Area / 277.4 (Square Inches)	$Q = \frac{720vA}{277.4}$ or Q = 2.595
Fluid Motor Torque (In Inch Pounds)	**Torque** = **Pressure** (psi) x **FM Displacement** ^{2} (cu,in,rev) / 2 π = **Horsepower** x 63025 / rpm = **Flow Rate** (gpm) x **Pressure** (psi) x 44.14 / rpm	$T = \frac{psi\ d}{2\pi}$ or $\frac{pd}{2\pi}$ $T = \frac{63025\ HP}{n}$ $T = \frac{44.14\ QP}{n}$ or $T = \frac{44.14\ Q\ psi}{n}$
Fluid Motor Torque (100 psi in Inch Pounds)	**Torque** /100psi = **FM Displacement** (Cu, Inches/Rev) / 0.628	$T/100\ psi = \frac{d}{0.0628}$
Fluid Motor Speed (In Rev/Min)	**Speed** = 277.4 x **Flow Rate** (gpm) IMP / **FM Displacement** (Cu, In/Rev)	$n = \frac{277.4\ Q}{d}$
Fluid Motor Power (In Horsepower Output)	**Horsepower Input** = **Torque Output** (Inches/Pounds) x rpm / 63025	$HP = \frac{Tn}{63025}$
Pump Outlet Flow In Gallons/min (IMP)	**Flow** = rpm x **Pump Displacement** (Cu, In/Rev) / 277.4	$Q = \frac{nd}{277.4}$
Pump Input Power (In Horsepower Required)	**Horsepower** = **Flow Rate Output** (gpm)(Imp) x **Pressure** (psi) / 1428 x **Efficiency** (Overall)	$HP = \frac{QP}{1428\ Eff}$ or $\frac{gpm\ x\ psi}{1428\ Eff}$
Flow Rate Through Piping (In Feet/second Velocity)	**Velocity** = 0.3852 x **Flow Rate through ID** (gpm) / **Internal Area** (square inches)	$v = \frac{0.3852Q}{A}$
Compressibility 1/2% Of Oil	**Additional Volume** = **Pressure** (psi) x **Volume of Oil Under Pressure** / 250,000	$VA = \frac{PV}{250,000}$ Approx. 1 1/2% per 1000 psi
Flow In Gallons/min (IMP)	**Flow** = **Flow Coefficiency** x $\sqrt{\text{**Pressure Drop** / **Specific Gravity**}}$	$Q = CA \sqrt{\frac{P1\ P2}{Sg}}$
Flow (Cu, Ft, Sec)	**Flow** = **Orifice Coefficient** x **Area** (sq.ft) x / 2 x **Press Head** (ft) x **Specific Gravity**	$Q = CA \sqrt{2HSg}$
Cooling Capacity (Horsepower)	**Cooling Capacity** = A constant x **Resurface Area** (sq. ft) / **Operating Temps Ambient Temps**	HP = 0.001 x A x T

Terms and Conditions

Orders are accepted subject to the following terms and conditions:

1 Exclusion of Terms
These Conditions of Sale apply to all Purchase of goods and services from us unless modified in writing by us prior to the acceptance by us of your order or instructions.

2 Acceptance
Neither estimates nor quotations nor any other documents or oral statements put forward by us or on our behalf constitute an offer to enter into contractual relations and no contract shall be created for the sale of any goods by us save by our acceptance of an offer.

3
Any acceptance by us of an offer to purchase goods shall incorporate these conditions of contract and no others and all offers shall be or shall be deemed to be made on that basis unless and except insofar as is expressly stated in writing by us with specific indication of what conditions are to be added or deleted or varied and in the event that any terms put forward by or on behalf of a party dealing with us shall have the effect of causing that which would otherwise have been an acceptance by us of an offer by such party to be in form or substance a counter offer such shall not be or shall be deemed not to be a counter offer but a mere invitation to treat and no contracts will be concluded save by a subsequent acceptance in writing by us to which these conditions apply.

4 Cancellation
If the buyer for any reason cancels the order after its acceptance by us or seeks to revise the delivery date, then the buyer shall be liable for all cost expenses and losses whatsoever including loss of profit resulting from such cancellation or revision. In particular cancellation will only be accepted on payment of all such costs expenses and losses incurred by us and until payment, cancellation of the order shall be deemed not to have taken place notwithstanding any instructions from the buyer to the contrary. Any payment made out of the provision of this paragraph to secure the cancellation of the contract shall be without prejudice to our right to recover any of the costs expenses and losses suffered by us as a result of such cancellation. Further, the buyer shall also be liable for all costs and expenses incurred by us on account of revisions of delivery dated necessarily due to lack of information from the buyer and we reserve the right in such circumstances to adjust any price quoted by us.

5 Delivery
While dates or periods for readiness or despatch or delivery of goods are given in good faith the same are not of the essence of or in any way terms of the contract or representation of fact and no damages shall be payable for late readiness or despatch or delivery however caused or under any circumstances and the Buyer shall be bound to accept goods sold when the same are ready for collection or are delivered.

6 Alterations
We reserve the right to modify prices should there be any agreed alteration in the design of goods. Prices given for equipment in stock or in progress are subject to the same being unsold when the order is received and accepted.

7 Drawings, etc.
All weights, measurements, powers, capacities and other particulars of goods offered by us, whether contained in illustrations or drawings, accompanying our tender or contained in our catalogues, price lists or advertisements, are stated in good faith as being approximately correct, but small deviations therefrom shall not be grounds for non-acceptance of the goods or otherwise vitiate any contract concluded between us, or be made on the basis of any claim against us.

8 Tests
All goods will be subject to standard works test prior to delivery which will be final and conclusive. Any additional tests required must be specified in your order and will be subject to acceptance by us and will be charged for.

9 Packing & Carriage
When 'delivered prices' are stated the price includes packing and carriage. If prices are 'ex-works' a charge will be made for packing and carriage can be arranged if required. Goods will be at your risk from the moment they are collected by your carrier. No credit will be issued for any packing returned.

10 Damage in Transit
When the price quoted includes delivery, we will repair or replace free of charge goods damaged in transit, provided the carriers and ourselves receive written notification of such damage within four days of delivery, and that the goods have been signed for as `not examined' or `damaged' but not otherwise.

11 Lost in Transit
Where we expressly undertake responsibility for delivery of goods we shall repair or replace the same or any part thereof at our own expense in the event of loss in transit to the point to which we agreed to deliver the goods provided that our liability hereunder shall in no circumstance exceed the price of the consignment of goods and provided that all claims in respect of loss in transit must be made in writing and delivered to our Head Office within the time limit stated by the carrier in the event of non-delivery. Save as aforesaid no responsibility whatsoever is accepted for any loss during the course of the transport of goods.

12 Schedule Orders
A scheduled order (i.e. an order calling for delivery spread over a period) shall constitute unqualified authority for manufacture and establishes the customers ultimate liability. Scheduling shall permit completion of delivery of an order within 12 months from the date that the order was received by us.

13 Price Adjustment
At our absolute and sole discretion the amount of the agreed contract price may be amended to allow for variation in the cost of labour or transport or machinery or materials or production occurring subsequent to the date on which the contract was made providing that the notice of the amendment be given to the buyer within 14 days of the delivery of goods or completion of the work as the case may be.

14 Terms of Payment
Prices quoted are net. Where no other terms of payment have been agreed, payment in respect of any of the goods shall be due one month from the date of despatch or from notification by us that they are ready for despatch. We reserve the right to charge interest at the rate of 1 1/2% per month for amounts not paid when due.

15 Patents
In the event of any claim being made or action being brought against you in respect of infringement of Patents by the manufacture or sale by us of goods supplied to you, you are to notify us immediately, and we shall be at liberty with your assistance, if required, to conduct all negotiations for the settlement of the same or any litigation that may arise therefrom. However, you shall indemnify us against all costs, claims, expenses, damages, charges or liabilities whatsoever in respect of or arising from any claim for infringement of Letter Patents, Trade Mark or Registered Design relating to any products supplied to your design following your instructions.

16 Nameplates
Any nameplate or other form of identification which we have affixed to or marked upon any articles sold by us shall not be removed by you or by anyone on your behalf without our consent in writing. No undertakings given in these Conditions of Sale shall apply to articles from which any of our nameplates or identification marks have been removed.

17 Design Modifications
Provided that the equipment as supplied gives the performance specified in our quotation, we reserve the right to alter or modify the design or layout of the equipment or any part thereof, or to add further parts or omit any parts mentioned in our quotation, and in any such case the price quoted by us shall neither be increased or decreased.

18 Law & Arbitration
These Conditions of Sale and any contract concluded pursuant to them shall be governed by and construed according to the Laws of England. If at any time any question, dispute or difference shall arise between us upon, in relation to, or in connection with the contract either of us may give to the other notice in writing of the existence of such question, dispute of difference, and the same shall be referred to the arbitration of a person to be mutually agreed upon, or failing agreement, to an arbitrator to be appointed by the President of the Law Society. This submission shall be deemed to be a submission to arbitration within the meanings of the Arbitration Act, 1950, or any statutory modification thereof. Work under the contract shall, so far as may be reasonably practicably, continued during the arbitration proceedings and no payments which may be or shall become due shall be withheld on account of such proceedings

19 Vesting
All goods sold by us whether delivered or installed or not, shall remain our sole property until all funds of whatever kind due to us for the sale or supply of such goods have been paid. Until the property in goods sold or supplied passes to the buyer, the buyer shall be responsible for any damage suffered to the goods and shall take all steps necessary to keep the goods in good condition and repair and shall keep the same in safe custody and shall not overload or overwork or in any way improperly use the same and shall not do any act or thing which leads or may lead to the goods being seized under distress or any legal process and shall at all time keep the goods comprehensively insured against all risks to their full price and shall take steps to effect that an endorsement shall be made on the policy recording our interest in the goods and providing that all money payable to the buyer under the policy shall be paid to us as agents for the buyer and the buyer hereby appoints us his agents for the purpose of receiving the said money and grants to us the right to satisfy from such sums any claims outstanding in our favour against him. Further at all time while goods are in the possession of the buyer but while the property therein remains in use the buyer shall notify us immediately if any defect arises is the condition of the goods and shall at all such times allow us access to the goods for the purpose of inspection and or work to the goods and we shall be entitled to but not obliged to carry out such work as we deem to be necessary to the goods and only such work and entitled to render to the buyer such charges for such work unless such work is in respect of defects in the goods which are the subject of an express undertaking by us under these terms.

20 Undertaking
Whilst we will use our best endeavours with regard to the design, quality of material and workmanship of the goods supplied, we give no warranty (and the goods are not sold subject to any condition) in respect thereof, nor shall any conditions or warranty in this regard be implied. In lieu there of we undertake to replace or repair at our option goods or parts thereof proved to have been originally defective in material or workmanship, if promptly returned to our Works, carriage paid within 12 months from the original date of despatch provided that we are satisfied after an examination of the good or parts returned that they are defective and that any such defects have not been caused by ordinary wear and tear, abuse, misuse, overloading, altered products or use of improper fluid. All warranties and conditions implied by Common Law, Statue or trade usage are hereby excluded. We shall not in any circumstances be liable for special, indirect or consequential loss or damage howsoever arising. Any materials which have been replaced by us, free of charge, shall become our property.

Webtec Products Limited
Registered No. 832125 London

Registered Office:
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Notes

Webster gear pumps and motors

A full range of cast-iron and aluminium gear pumps and motors are available.

Suitable for a variety of applications, including mobile equipment, mining and fan drive systems. Each series is available in a variety of sizes.

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In addition, Webtec are also able to supply many replacement special type pumps and motors which are fitted to major OEM's mobile machines, including the 237 YDA special Matbro Pump (P19196).

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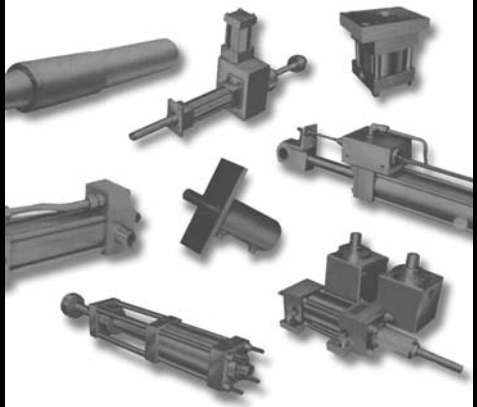

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