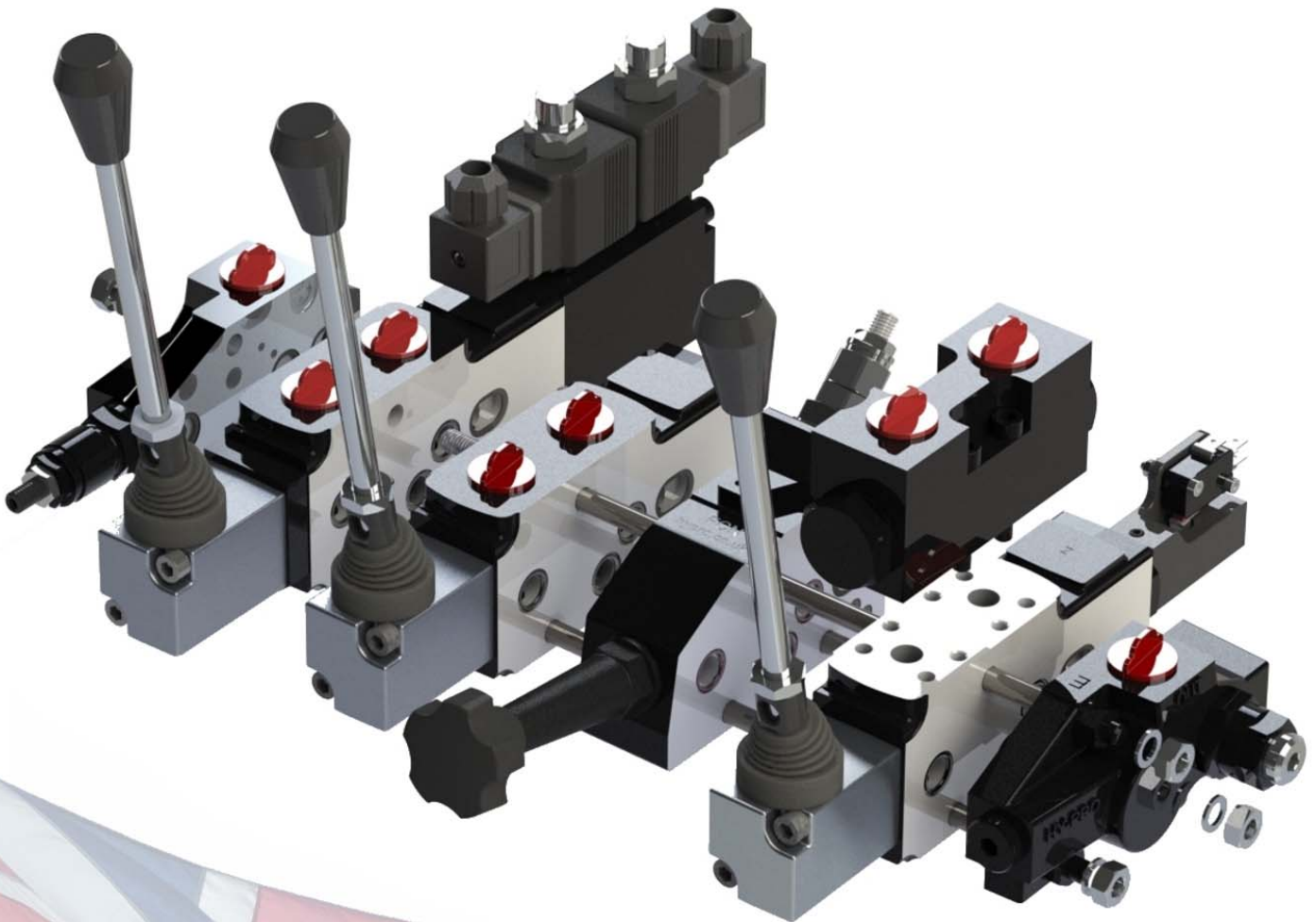


# Hy-Pro

motion and control solutions



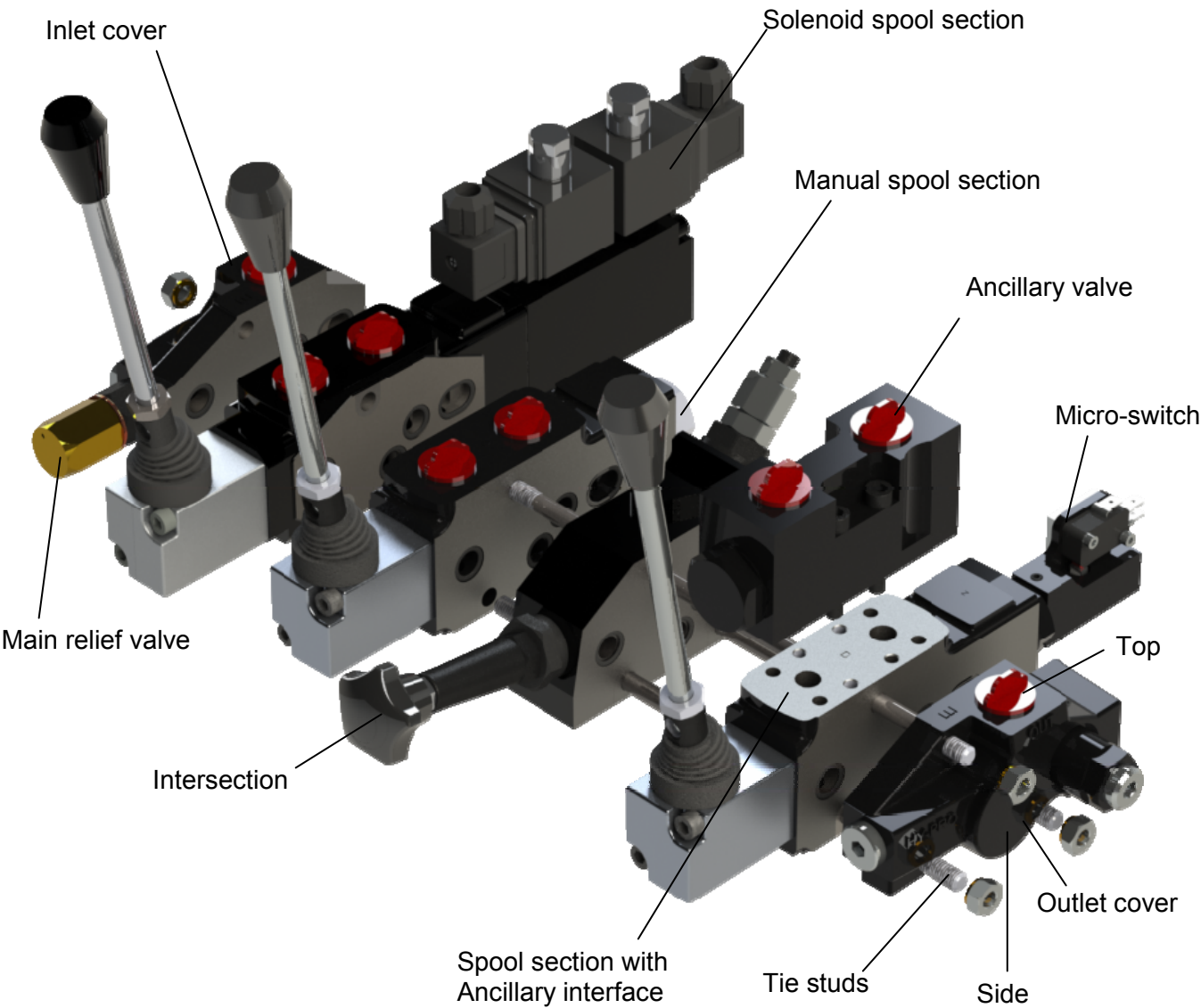
## Sectional Spool Valve Manual

The information in this manual was, to the best of our knowledge, correct when it went to press and Hydraulic Projects Ltd cannot be liable for any inaccuracies or omissions. There may also be differences between the specifications in the manual and the product as a result of ongoing development for which we accept no liability.

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Sectional spool valve anatomy



## Description

V4-40 – G3/8 40 L/min  
V5-60 – G1/2 60 L/min  
V3-100 – G3/4 100 L/min

### Introduction and overview

A family of parallel connected sectional spool valves with integral load holding check valves in 3 flow ranges and port sizes with actuator and ancillary options. Designed and manufactured in the UK by Hydraulic Projects Ltd and marked with the 'Hy-Pro' trademark.

Manually and pilot solenoid operated valve sections are available with a maximum operating pressures of 250 bar for manual and 210 for the solenoid (the solenoid armature tube being the limiting factor as specified by the manufacturer).

Solenoid and manual sections can be assembled into the same bank but the maximum operating pressure will be limited to 210 bar

They can be used in open centre or closed centre circuits with a change of Inlet cover.

Some components are universal across the V4-40 and V5-60. Studs sets, spool centering and detent mechanisms, micro switch assemblies and certain seal kits, cartridges, ancillary and intersection valves.

### Spools, Mechanisms, Actuators and Micro-switches

Each range has family of spools to suit most applications with standard or fine metering options and 2,3 and 4 position detent / spring centring mechanism combinations.

Actuation options are manual levers – standard / rotary / dual axis (x & +), cable, direct link to the spool or pilot solenoid (with or without manual lever override).

The standard manual lever assembly has four orientation options and is universal across the range.

Lever knobs are available in a variety of colours.

Spool operated single or twin V3 series micro-switch assemblies can be fitted to manual sections with the option of IP67 environmental protection.

### Valve body sections

Each family has the following body alternatives -

Manual 2 / 3 position - threaded service ports

Manual 4 position - threaded service ports (engraved '4' on the pad, additional internal machining – only to be used with 4 position spools)

Manual 2 / 3 position - 4 x M6 holes on port face (engraved 'Z' on the pad)

Manual 2 / 3 position - 4 x M6 holes and return drillings on port face (engraved 'Y' on the pad)

Solenoid 2 / 3 position – threaded service ports

Solenoid 2 / 3 position - 4 x M6 holes on port face (engraved 'Z' on the pad)

Solenoid 2 / 3 position - 4 x M6 holes and return drillings on port face (engraved 'Y' on the pad)

Please note that the valve section and spool are a match honed pair and it is not advisable to swap components. Excessive internal leakage or spool stick may occur.

### Inlet and Outlet Covers

Inlet and Outlet end covers have top and side port options in various 'G' thread sizes designated by the number of 'eighths of an inch' in the thread size (e.g. T4 = Top G1/2). End covers for use with solenoid controlled sections have additional drillings for the pilot connections and are engraved 'E' on the top face. Also the solenoid Outlet cover contains the Pilot Pressurising Cartridge. If a solenoid section is used with manual sections in a bank, 'E' type Inlet and Outlet covers must be used.

Pressure Carry Over outlet covers are available for both manual and solenoid valve banks. The same rules as above apply.

## **Main and Service Line Relief Valves**

Direct acting or pilot operated main relief valve options are available for each range and fit into the same Inlet cover cavity. All relief valves are factory set at 140 bar @ 20 L/min. unless otherwise requested.

The direct acting Service Line Relief Valve pressure setting will be at the 'crack' condition unless a specific flow rate is requested. See the catalogue for typical flow v. pressure rise performance.

## **Solenoid Pilot Controlled Sections**

The solenoid version operates via a valve in the Outlet cover to provide pilot pressure to initially move the spool. Solenoid coils are 24w and available in 12 and 24v DC or 110v AC. Black 90° IP67 Hirschman connectors for use with Ø 4 – 9 mm cable, 1.5 mm<sup>2</sup> max. conductor are supplied as standard. Because is a piloted system, when manual lever assemblies are fitted to a section the lever will move when the solenoids are energised and hydraulic supply is on. If the hydraulic supply is off, the levers will not move when the solenoids are energised.

## **'Bolt On' Service Port valves - 'Y' and 'Z' sections**

Bolt on manifold type service port pilot operated check, relief & anti-cavitation and cross line relief valves are available in a variety of options. They mount onto 'Y' and 'Z' body sections and are available for manual and solenoid versions.

A solenoid 4<sup>th</sup> position assembly for solenoid operated sections is also available as a bolt on.

Pilot operated check and cross line relief valves fit onto 'Y' type sections.

Solenoid 4<sup>th</sup> position, service line relief and anti-cavitation valves fit onto 'Z' type. Pilot checks can also be fitted to these.

## **Intersection Valves**

Circuit building blocks include Series, Series Parallel, Mid Inlet, Spacer and Mid Mounting plates.

Flow Divider and Flow Control intersections (series or parallel connected, with relief valve and metering valve options) are available with rotary knob, screw with locknut, fixed orifice or electronic control with a PWM driver.

A solenoid controlled Unloader section (using standard coils) with manual override and relief valve options is also available for hydraulic circuits that require an emergency stop electrical interface.

## **Environmental Protection**

As standard all assemblies are treated with corrosion protective paint which can be readily over coated if required. External steel parts are plated or stainless steel. For harsh environmental conditions further corrosion resistance options are anodised aluminium components and stainless steel levers. The build code suffix 'M' is used to designate this.

## **Quality and identification**

All components and sub assemblies are performance and function tested to documented standards before dispatch and are engraved with the part code, date code, website and inspectors identification stamp.

The spool type in a valve body is letter stamped between the service ports or on the pad if 'bolt on' ancillaries are used.

IN, OUT and PCO (pressure carry over) ports are identified with engraved or cast letters.

Items are individually heat sealed poly bagged and carry an identification label showing Hy-Pro Work Order number, Customer name, Customer P/O number, Hy-Pro part number, description and quantity (if more than one).

## **Note.**

This list is neither conclusive nor exhaustive. Please talk to our technical staff with any assembly, test or application queries.

## Design and basic function

The three valve ranges follow the same hydraulic circuit layout.

Each SPOOL VALVE SECTION has seven cast galleries -

- 2 x through centre
- 2 x return
- 2 x service
- 1 x parallel
- and two drillings
- 1 x pilot pressure line
- 1 x pilot return line

The through centre galleries provide a 'zig zag' path through the section.

The return galleries are adjacent to each service gallery.

The service galleries connect to the A and B service ports.

The parallel gallery in each section incorporates a load holding check valve to prevent a high pressure function supplying low pressure function when both are actuated simultaneously and is located between the service galleries.

Each section connects these galleries with the next and the interfaces are sealed with O rings.

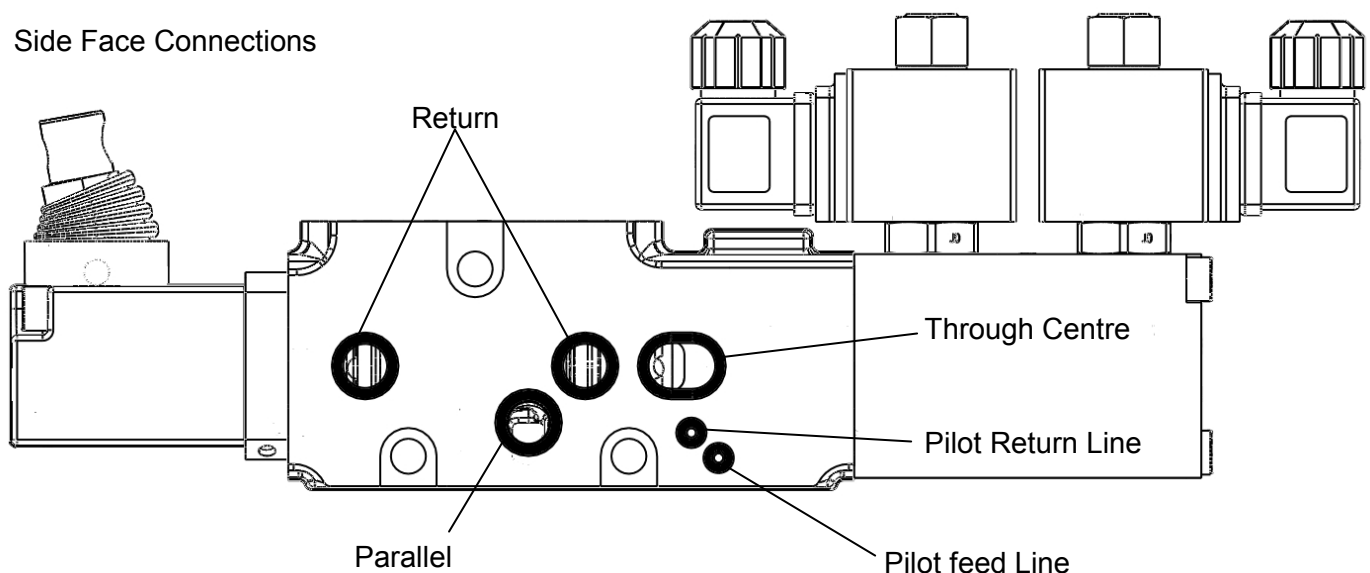
INLET and OUTLET COVERS for solenoid pilot controlled sections have additional connections to the pilot pressure line and pilot return line respectively.

The INLET COVER connects to the adjacent valve section through centre and parallel galleries. If a relief valve is incorporated it connects the bypass flow to one return gallery of the adjacent valve section. It also feeds the pilot pressure line and blanks off the pilot return line.

The OUTLET COVER connects the through centre, return galleries and pilot drain line from the adjacent valve section together and connects them to the outlet port. It also blanks off the parallel gallery and the pilot pressure line.

A PRESSURE CARRY OVER OUTLET COVER separates the through centre flow from the return flow and connects it to separate additional port. This allows the flow to be used downstream whenever the valve is in neutral. It also blanks off the parallel gallery and the pilot pressure line.

### Side Face Connections



When any SPOOL SECTION in a bank is operated three occurrences happen (more or less\*) simultaneously...

The through centre closes.

The parallel gallery is opened to a service port.

The opposite service port is opened to the return gallery.

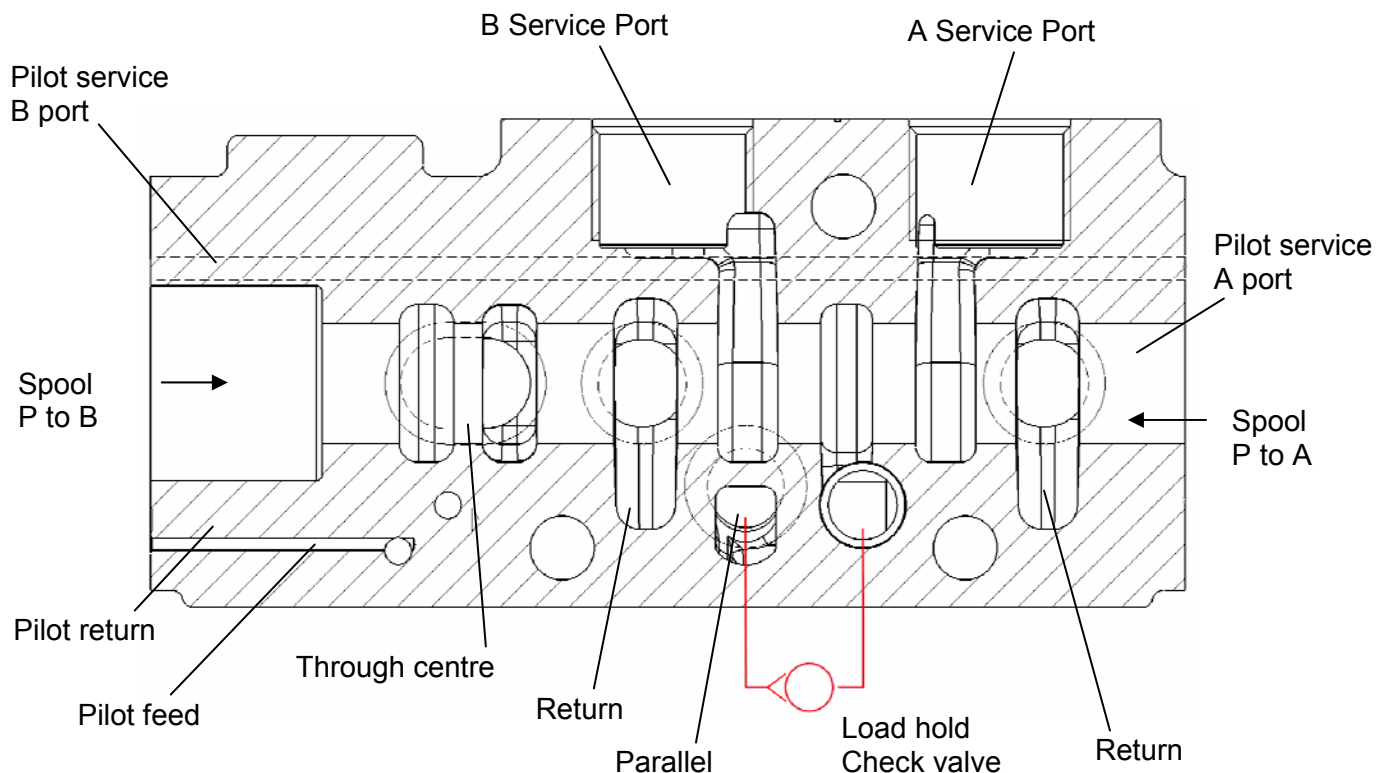
...and vice versa for the service ports when operated in the opposite direction.

Various spool geometries are available to give meter-in or out characteristics.

When any SPOOL SECTION is operated in a bank, the parallel gallery in all the other sections is at the service pressure and flow is available to any / all sections if they are operated. The lightest load services will take priority unless the spool metering is used.

SOLENOID SPOOL SECTIONS are operated from a pilot system consisting of pressure and return lines that run through each section and connected to the INLET and OUTLET covers. A cartridge in the OUTLET cover through centre gallery generates a low pressure for the pilot line as described earlier.

Each SOLENOID SECTION has a manifold, with two solenoid cartridge valves, which is connected to the pilot lines. Drillings in the section also connect to either end of the main spool. With the cartridges in the de-energised condition the main spool ends are connected to the pilot return line and the spool is spring centred. Energising either cartridge coil switches pilot pressure to the selected end of the main spool and operates it. An orifice is built into the circuit to dampen the action. When the spool has moved to the operating position and the through centre has closed, the pressurising valve is no longer in the circuit and the spool is held across by the service port pressure fed from the INLET cover. De energising drains the main spool to the pilot return line and allows it to spring centre to neutral. The pilot system is also parallel connected allowing multi section operation.



## General assembly instructions

### Keep it clean

Cleanliness is the primary means of assuring long life and reliable function of all the components in an hydraulic system.

When assembling or dismantling valves keep the work area and tools clean, cover up any components that are left unattended with a clean layer of plastic. Do not allow foreign material, chemicals or water to come into contact with components.

If a used valve is to be dismantled for repair or modification drain all fluid from the assembly and plug all the ports. Clean the outside of the valve thoroughly with a non-solvent based wash and compressed air dry.

Dismantle the valve and carefully clean all interfaces.

### O Rings, Storage and Assembly

To prevent degradation keep seal kits and O rings away from heat and light and in sealed bags until required.

Replace seals with genuine Hy-Pro items.

Always lightly lubricate O rings before assembly using a quality petroleum based grease, this will also help 'stick' interface seals in place.

### Assembling valve sections

Only use Hy-Pro supplied high tensile tie studs, nuts and socket head cap screws!

Tools required –

- 1) Calibrated 3/8" □ drive torque wrench set to the specified value.
- 2) 3/8" □ drive ratchet.
- 3) 2 x 3/8" □ drive 13mm AF sockets.
- 4) A flat firm non splintering surface to ensure the assembly does not twist.

The recommended procedure is to put the spring washer and nut evenly on one end of each tie stud, put them through the Inlet cover holes and horizontally mount each section in order along the studs ensuring the interface O rings stay in place. Finally assemble the Outlet cover, spring washers and nuts. Tighten the nuts progressively and finally torque to the specified value. 'One click!'

### Assembling Service Port ancillary valves

Tools required –

- 1) Calibrated 3/8" □ drive torque wrench set to the specified value.
- 2) 5mm AF hexagon key on 3/8" □ drive socket.
- 3) Loctite 222 low strength thread locking adhesive or proprietary equivalent.

Check the manifold and valve mounting faces are clean, O rings are in place and correctly located.

Apply a minimal amount of adhesive into each female thread. Important! Ensure that no adhesive gets between the mating faces!

Locate the ancillary valve (the correct way round if specified) onto the section top face assembly, insert and progressively tighten the 4 x M6 socket head cap screws supplied and finally torque to the specified value. 'One click!'



## Assembling lever housings

Tools required –

- 1) Calibrated 3/8" □ drive torque wrench set to the specified value.
- 2) 5mm AF hexagon key on 3/8" □ drive socket.
- 3) Loctite 222 low strength thread locking adhesive or proprietary equivalent.
- 4) 17 mm AF open ended spanner

The lever housing is supplied pre lubricated with anhydrous grease and the lever loosely assembled. Remove the lever with locknut.

Apply a minimal amount of adhesive into each female thread in the valve section.

Important! Ensure that no adhesive gets into the mechanism or on the spool.

Orientate the housing as specified, pull the lever base back and locate the ball end into the spool hole. Insert and progressively tighten the 2 x M6 socket head cap screws supplied and finally torque to the specified value.

Assemble the lever in the specified orientation and tighten the locknut.

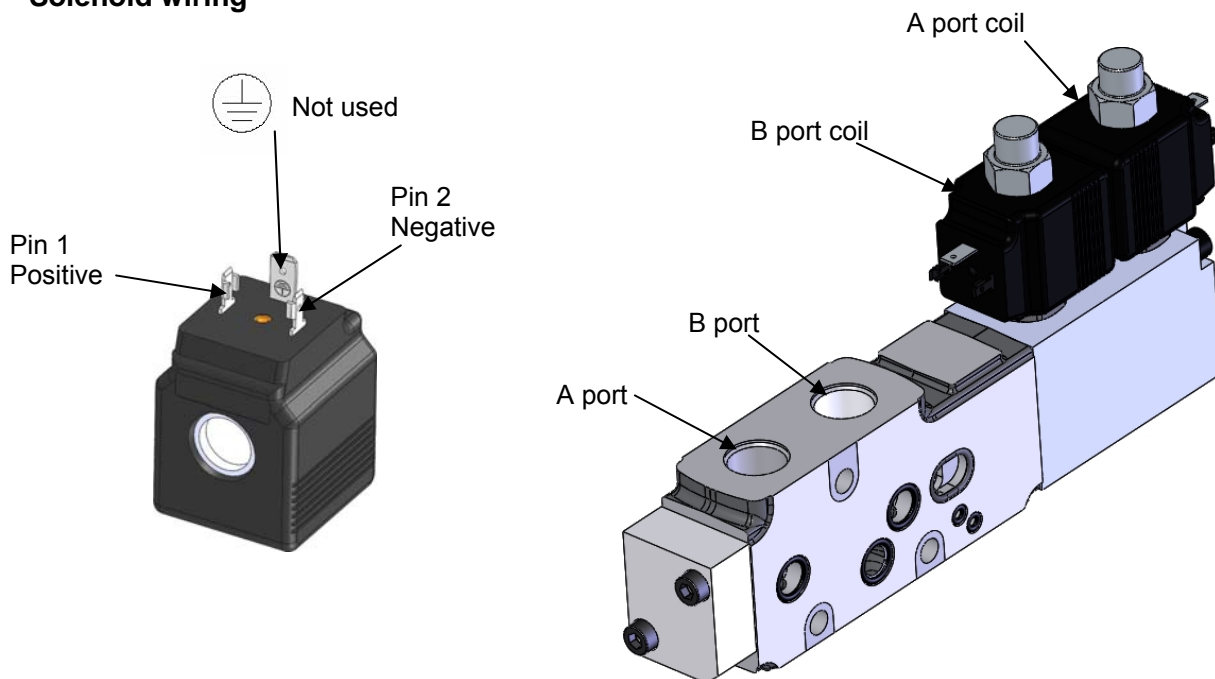
## Assembly bench checks

Please note that the valve mounts on the machined pads on the bottom of the Inlet and Outlet covers and must sit flat after assembly. If it rocks, slacken the studs, correct and re torque.

Check the levers operate correctly with no sticking or hesitation. If a lever sticks the problem will be –

- 1) A trapped interface O ring – dismantle, check and replace with new.
- 2) Debris trapped between the interfaces – dismantle, check and clean.
- 3) Incorrect tie stud / lever housing or ancillary valve fastener torque – check tool setting / calibration. Correct and re assemble and retest.

## Solenoid wiring



**If in doubt – ask!**

## Summary of features

VALVE RANGE		V4-40	V5-60	V3-100
<b>Performance</b>	Rated flow	40 Lpm	60 Lpm	100 Lpm
	Port size Inlet	G3/8	G1/2	G3/4
	Port size Service	G3/8	G1/2	G3/4
	Port size Outlet	G1/2	G1/2 G3/4	G3/4 G1
	Max pressure manual valves	250	250	250
	Max pressure Solenoid valves	210	210	210
	Load hold check	Y	Y	Y
<b>Protection</b>	Marine enviroment protection	Y	Y	Y
<b>Relief valves</b>	Relief valve direct acting	Y	Y	-
	Relief valve pilot operated	Y	Y	Y
<b>Spools manual</b>	D - Cylinder	Y	Y	Y
	M - Motor	Y	Y	Y
	A - Single acting 'A' port	Y	Y	Y
	B - Single acting 'B' port	Y	Y	Y
	K - Cylinder fine metering	Y	Y	-
	MF - otor fine metering			-
	4 - 4th position float	Y	Y	Y
<b>Spools solenoid</b>	D - Cylinder	Y	Y	Y
	M - Motor	Y	Y	Y
	A - Single acting 'A' port	Y	Y	Y
	B - Single acting 'B' port	Y	Y	-
<b>Mechanisms</b>	3 position spring	Y	Y	Y
	3 position Detent	Y	Y	Y
	3 position spring/detent	Y	Y	Y
	3 position float detent	Y	Y	Y
	2 position spring	Y	Y	Y
	2 position Detent	Y	Y	Y
	4 position	Y	Y	Y
	Microswitch	Y	Y	-

VALVE RANGE		V4-40	V5-60	V3-100
<b>Intersections</b>	Flow Control	Y	Y	Y
	Flow Divider	Y	Y	-
	Proportional flow control (Electronic)	Y	Y	-
	Proportional flow divider (Electronic)	Y	Y	-
	Solenoid unloader	Y	Y	-
	Series plate	Y	Y	Y
	Mid inlet	Y	Y	-
	5mm Spacer plate 19mm Mid mount plate > 10 sections	Y	Y	-
<b>Ancillaries</b>	Pilot check valve	Y	Y	-
	Service line relief	Y	Y	-
	Cross line relief	Y	Y	-
	Solenoid 4th position float	Y	Y	-
<b>Control</b>	Lever	Y	Y	Y
	Multi axis lever X and +	Y	Y	-
	Solenoid pilot	Y	Y	Y
	Cable	Y	Y	Y
<b>Inlet cover</b>	Top port	Y	Y	Y
	Side port	Y	Y	Y
	Gauge port	Y	Y	Y
	Closed centre	Y	Y	Y
	Relief valve	Y	Y	Y
	Unloader valve	Y	Y	-
<b>Inlet cover solenoid (V4-40 &amp; V5-60 only) V3 solenoid uses Standard inlet cover</b>	Top port	Y	Y	-
	Side port	Y	Y	-
	Gauge port	Y	Y	-
	Closed centre	Y	Y	-
	Relief valve	Y	Y	-
	Unloader valve	Y	Y	-
<b>Outlet cover</b>	Top port	Y	Y	Y
	Side port	Y	Y	Y
	Top port with PCO	Y	Y	Y
	Side port with PCO	Y	Y	Y
<b>Outlet cover solenoid</b>	Top port	Y	Y	Y
	Side port	Y	Y	Y
	Top port with PCO	Y	Y	-
	Side port with PCO	Y	Y	-

## Torque settings

Item	Part no.	Torque (Nm)
<b>Tie studs (M8)</b>	-	13.5
Mounting bolts (M8)	-	13.5
<b>Port fittings</b>	G1/8	10-12
	G1/4	20-25
	G3/8	40-45
	G1/2	70-75
	G3/4	130-135
<b>Solenoid cartridges</b>		
V4-40E, V5-60E, V3100E	V5533-O	27
	V5533-C	27
	Coil retaining nut	8.5
4 position Solenoid cartridge 4XX	V3880-C	27
Proportional	V53961	27
Solenoid cartridges	V52900	27
FCE, FDE, FCEN, FDEN	V53471	27
Flow divider	V5307	27
Cartridges	V5393	68
FDE, FDEN		
<b>Intersections</b>		
Flow control & unloader	V53411	27
by-pass cartridges	V53412	27
FCN, FC60, U	V53413	27
	V53414	27
Flow control	V53760	27
needle cartridges	V53762	27
FCN, FC60	V53763	27
	V53764	27
	V53765	27
	V53766	27
<b>Ancillary manifolds (M6)</b>		
Service line relief	V4111	8
Pilot checks	V4112	8
4 Position float	V4113	8
	V5218	8
	V5221	8
	V5223	8
	V5319	8

Item	Part nos.	Torque (Nm)
<b>Lever housing bolts (M6)</b>		
Manual valves	V5 H	8
Solenoid valves	V5E H	13.5
Solenoid manifold bolts (M6)	V5505	16
Spring offset manifold	V5530	16
<b>Spool mechanisms</b>		
Spring housing		27
Detent housing		27
4 Positon housing		27
Spring stop bolt		8
Detent plug		8
4 Positon bolt		13.5
<b>Outlet cover</b>		
Pressurising valve cartridge	V5410	27

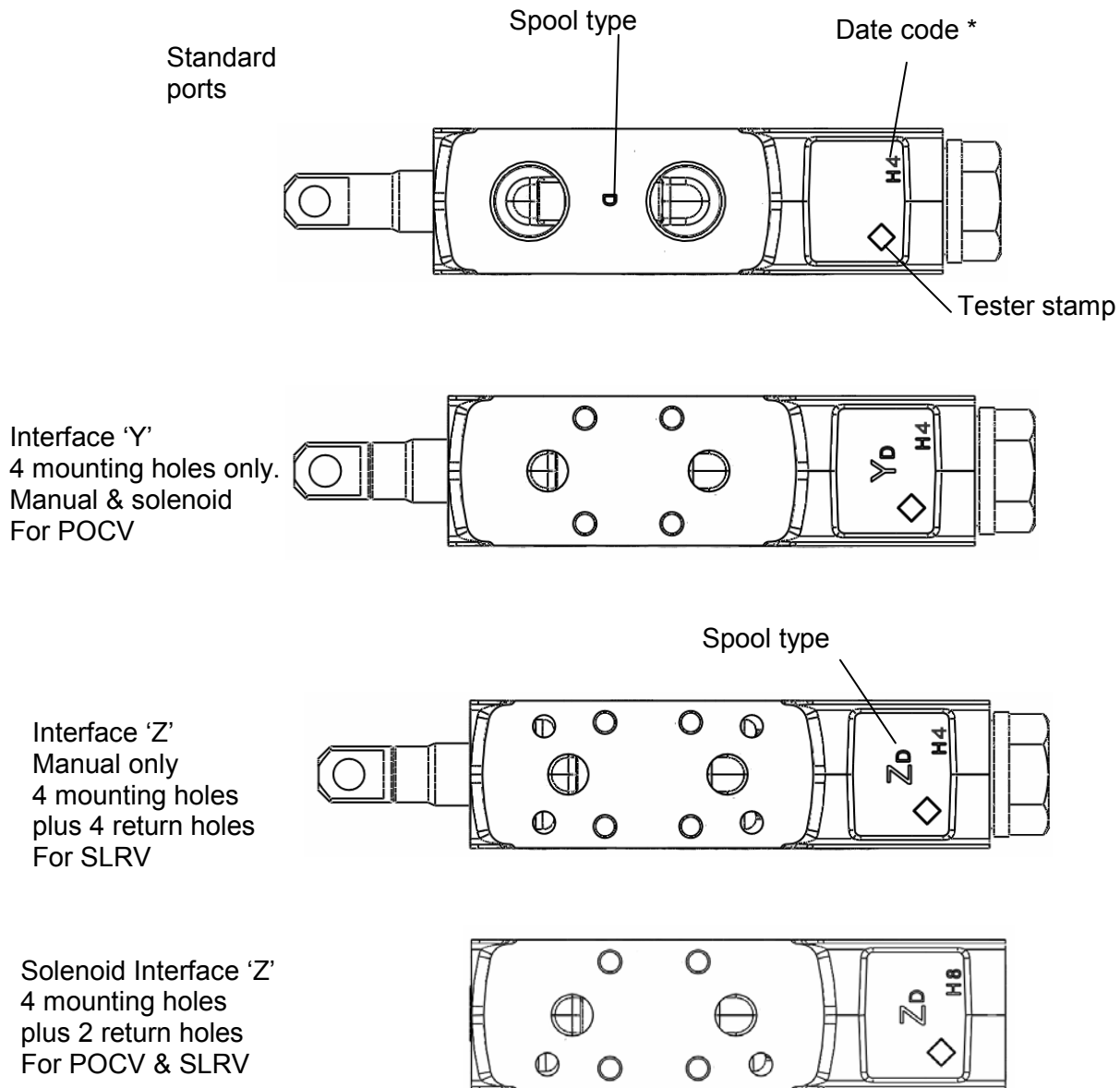
#### Tie stud lengths (mm)

No of sections	Hy-Pro stud kit	
	V4-40 & V5-60	V3-100
1 section	080	130
2 sections	130	169
3 sections	169	215
4 sections	215	262
5 sections	250	305
6 sections	287	344
7 sections	324	395
8 sections	355	437
Studs per kit	3	4
Nuts & washers	6	8

#### Non standard stud length calculation

Standard section width (x No. off sections)	38.1	44.5
Series plate	19.0	25.4
Flow control / divider with series link	50.8	-
Both end covers	30.2	57.2
Allowance for nuts & washers	25.0	25.0
Allowance for additional/optional mounting feet (V3-100 E only)	-	10.0

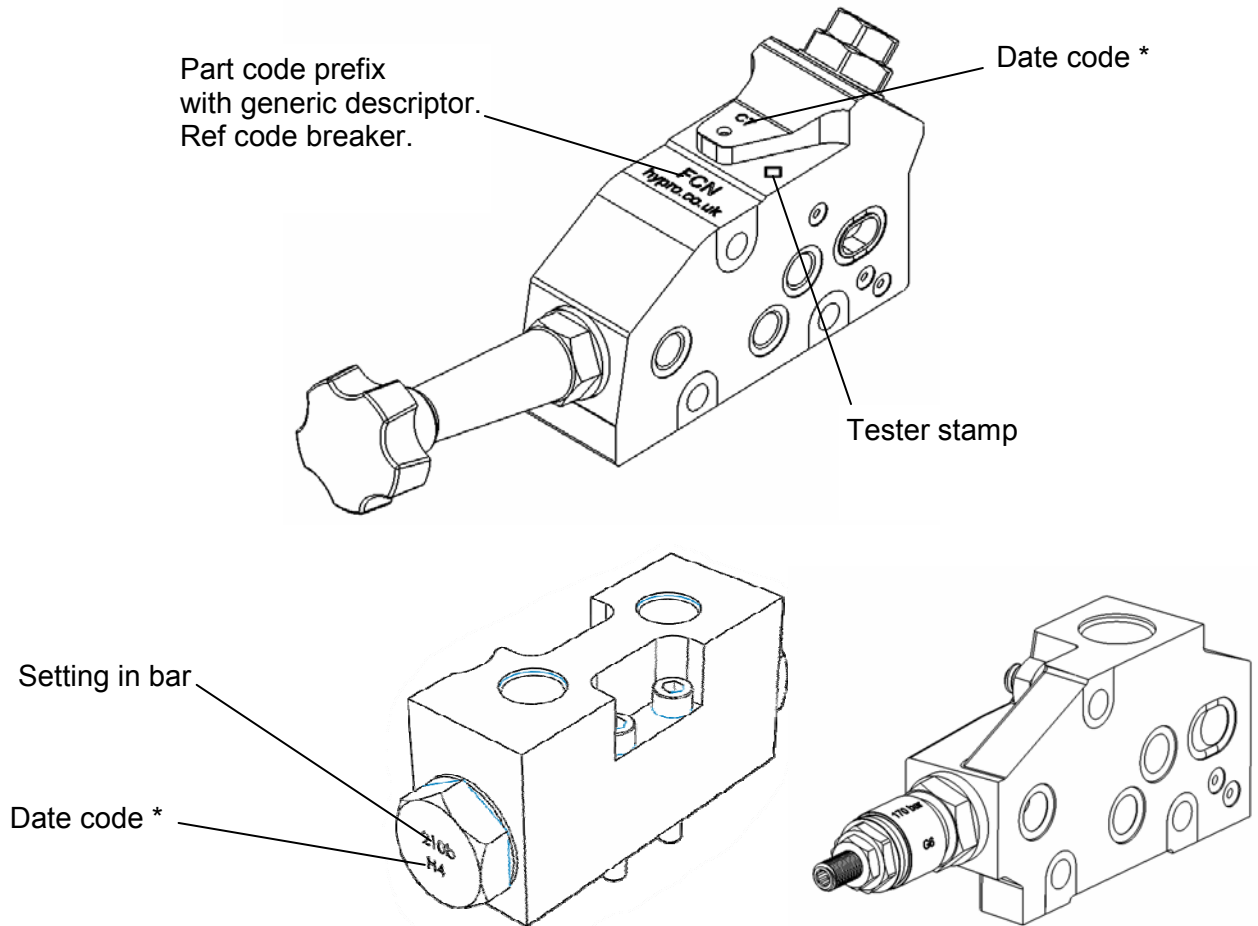
## Identification markings - spool sections



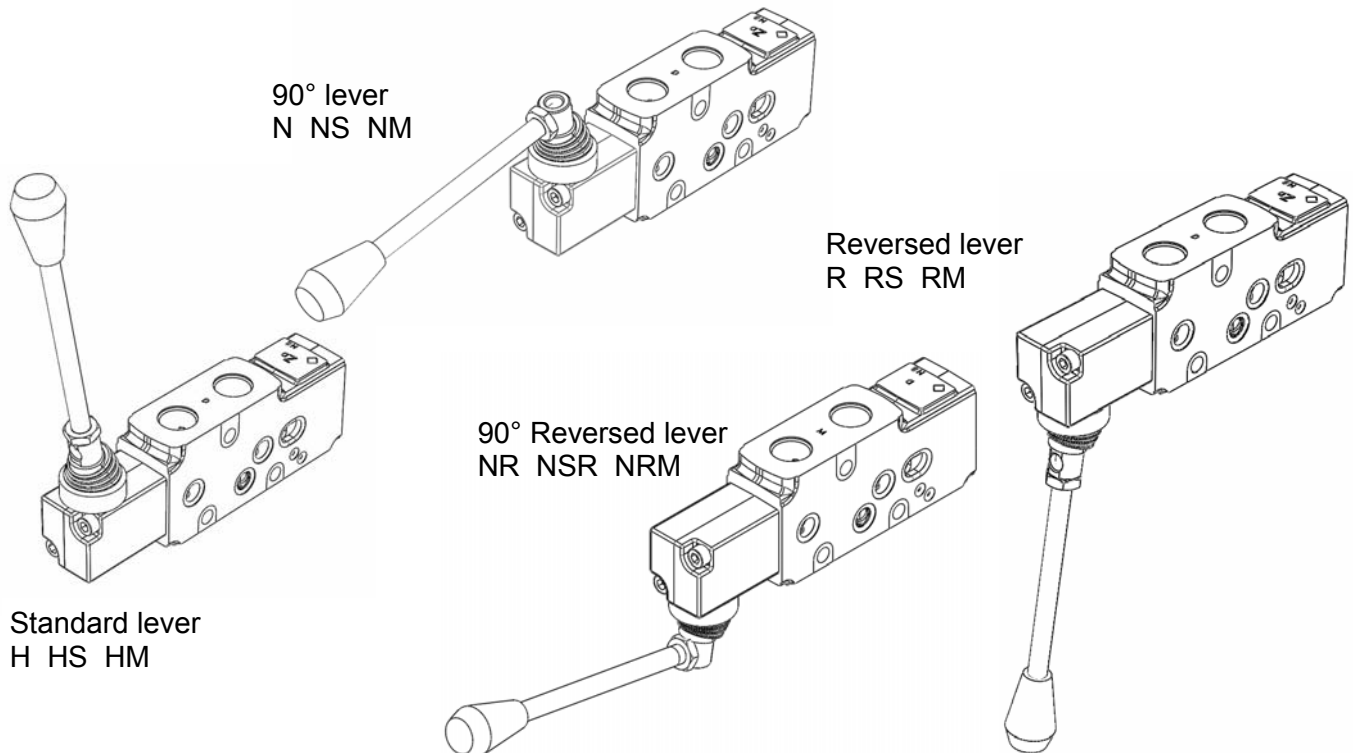
### \*Date code

Letter	Number
A - January	0 - 2010
B - February	1 - 2011
C - March	2 - 2012
D - April	3 - 2013
F - May	4 - 2014
G - June	5 - 2015
H - July	6 - 2016
I - August	7 - 2017
J - September	8 - 2018
K - October	9 - 2019
L - November	
M - December	

## Body markings - Intersections, ancillaries and relief valves



## Lever orientations



H = Standard lever (zinc chromate) and untreated aluminium housing  
 HS = Stainless lever and untreated aluminium housing  
 HM = Stainless lever and anodised aluminium housing

## Code breaker

A summary of the coding used in all HyPro sectional valves.  
Refer also to the main product catalogues.

Valve assemblies which contain solenoid sections must be used with matching inlet and outlet covers.  
The last letter of the code is 'E'. The covers are machined with an 'E' ident. Letter.

### Inlet covers & Special inlets

Code	Inlet covers					
	Relief valve	Setting	Port position	Port size	Function	Operation
<b>BLANK</b>	No relief valve					
<b>R</b>	Relief valve direct acting					
<b>P</b>	Relief valve pilot operated					
<b>X</b>		XXX pressure in bar				
<b>S</b>			Side			
<b>T</b>			Top			
<b>1</b>				1 G1/8		
<b>2</b>				2 G1/4		
<b>3</b>				3 G3/8		
<b>4</b>				4 G1/2		
<b>6</b>				6 G3/4		
<b>8</b>				8 G1		
<b>C</b>					Closed centre	
<b>E</b>						Electric (solenoid)

Examples:

R140 T4 = R/V set 140b, top port G1/2  
T6C = Top G3/4 port, closed centre.  
S4E = Side G1/2 for solenoid valves

### Outlet covers

Code	Outlet covers			
	Port position	Port size	Function	Operation
<b>S</b>	Side			
<b>T</b>	Top			
<b>1</b>		1 G1/8		
<b>2</b>		2 G1/4		
<b>3</b>		3 G3/8		
<b>4</b>		4 G1/2		
<b>6</b>		6 G3/4		
<b>8</b>		8 G1		
<b>O</b>			Standard Outlet	
<b>P</b>			Pressure Carry Over	
<b>FCO</b>			Flow Control Outlet	
<b>E</b>				Electric (solenoid)

Examples:

T3O = Top port G3/8  
S4P = Side port, G1/2, pressure carry over  
T4PE = Top port G1/2, pressure carry over for solenoid valves



## Spool sections - Manual

Code	Manual spool section					
	Spool	Positions	Body type	Centring	Actuator	Protection
<b>A</b>	<b>A</b> port single acting					
<b>B</b>	<b>B</b> port single acting					
<b>D</b>	<b>D</b> ouble acting					
<b>M</b>	<b>M</b> otor					
<b>K</b>	<b>K</b> double acting, fine metering					
<b>MD</b>	<b>A</b> ' <b>M</b> otor, ' <b>B</b> ' <b>D</b> ouble					
<b>MF</b>	<b>M</b> otor, <b>F</b> ine, meter in					
<b>P</b>	<b>P</b> unloading spool - 2 position					
<b>4</b>	<b>4</b> position	<b>4</b>	<b>4</b> four position			
<b>Y</b>			<b>Y</b> interface PCV & XLRV			
<b>Z</b>			<b>Z</b> interface SLRV			
<b>2</b>		<b>2</b> position				
<b>C</b>				spring <b>C</b> entered		
<b>L</b>				detent <b>L</b> ocated		
<b>Li</b>				detent <b>L</b> ocated <b>I</b> n		
<b>O</b>				Fricti <b>O</b> n detent		
<b>X</b>					<b>X</b> no lever	
<b>H</b>					<b>H</b> andle - standard	
<b>R</b>					<b>R</b> eversed lever	
<b>N</b>					<b>N</b> inety degree lever	
<b>HO</b>					<b>H</b> andle - <b>r</b> Otary	
<b>H+</b>					<b>H+</b> multi axis lever	
<b>Hx</b>					<b>Hx</b> multi axis lever	
<b>M</b>						<b>M</b> arinised
<b>S</b>						<b>S</b> tainless lever
	Note! See SI 592					

Examples:

DCH = Double Acting spool, spring centred, standard lever

M2LR = Motor spool, 2 position, detent, reversed lever

4ZCH = 4 position spool and interface body, spring centred with detent into 4th position, standard lever

DZCHS = Double Acting spool, interface body, spring centered, stainless steel lever

## Spool sections - Solenoid

Code	Solenoid pilot spool section						
	Spool	Positions	body type		Actuator	Protection	Voltage
<b>A</b>	<b>A</b> port single acting						
<b>B</b>	<b>B</b> port single acting						
<b>D</b>	<b>D</b> ouble acting						
<b>M</b>	<b>M</b> otor						
<b>2</b>		<b>2</b> position					
<b>Z</b>			<b>Z</b> Ancillary interface				
<b>E</b>				<b>E</b> lectric (solenoid)			
<b>H</b>					<b>H</b> andle - standard		
<b>N</b>					<b>N</b> inety degree lever		
<b>R</b>					<b>R</b> eversed lever		
<b>S</b>						<b>S</b> tainless lever	
<b>12</b>							<b>12</b> VDC
<b>24</b>							<b>24</b> VDC
<b>110</b>							<b>110</b> VAC
	Note! See SI 592						

Examples :

DEH 12 = Double acting with lever override 12VDC

MZEH 110 = Motor, body with interface, lever override 110 VAC

AE 24 = Single acting no lever override 24VDC

## Intersections - unloaders

Code	Unloader sections			
	Type	Relief valve	Setting in bar	Voltage
<b>US</b>	Unloader <b>S</b> crew override			
<b>R</b>		Relief valve		
<b>XXX</b>			<b>XXX</b> pressure in bar	
<b>12</b>				<b>12VDC</b>
<b>24</b>				<b>24VDC</b>

Examples :

US R140 12 = Unloader section with R/V set 140b, 12VDC

US 24= Unloader section, 24 VDC

## Intersections - flow control manual

Code	Manually adjusted flow controls						
	Type	Control	Metering	Relief valve	Setting in bar	Circuit	Protection
<b>FCN</b>	Flow <b>C</b> ontrol ma <b>N</b> ual						
<b>K</b>		<b>K</b> nob					
<b>S</b>		<b>S</b> crew					
<b>C</b>		<b>C</b> able					
<b>SX</b>		<b>S</b> et flow ( <b>X</b> = L/min)					
<b>L</b>			Limited to 1 turn				
<b>F</b>			<b>F</b> ine				
<b>O</b>			no shut <b>O</b> ff				
<b>R</b>				Relief valve			
<b>XXX</b>					<b>XXX</b> pressure in bar		
<b>S</b>						<b>S</b> eries	
<b>M</b>							<b>M</b> arinised

Examples:

FCN K = Manual flow control, knob operated

FCN S R190 S = Manual flow control, screw operated, R/V set 190b, series connected

FCN S5 R100 = Manual flow control, set 5L/min, R/V set 100b,

## Intersections - flow control solenoid

Code	Electronic proportional flow controls					
	Type	Voltage	Relief valve	Setting in bar	Circuit	Protection
<b>FCE</b>	Flow <b>C</b> ontrol Sol <b>E</b> noid					
<b>12</b>		<b>12VDC</b>				
<b>24</b>		<b>24VDC</b>				
<b>R</b>			Relief valve			
<b>XXX</b>				<b>XXX</b> pressure in bar		
<b>S</b>					<b>S</b> eries	
<b>M</b>						<b>M</b> arinised

Examples:

FCE 12 R140 S = Proportional flow control, 12VDC, R/V set 140b, series connected

FCE 24 R90 = Proportional flow control, 24VDC, R/V set 90b

## Intersections - flow dividers manual

Code	Manual flow dividers				
	Type	Control	Metering	Circuit	Protection
<b>FD</b>	<b>Flow Divider manual</b>				
<b>K</b>		<b>Knob</b>			
<b>L</b>			<b>Limited 1 turn</b>		
<b>S</b>		<b>Screw</b>			
<b>S</b>				<b>standard</b>	
<b>X</b>				<b>no inlet port</b>	
<b>XT</b>				<b>sec' tank port</b>	
<b>PST</b>				<b>priority &amp; sec' tank port</b>	
<b>M</b>					<b>Marinised</b>

Examples :

FD KL S = Knob operated with inlet port

FD S XT= Screw operated with series link, secondary flow tank port.

## Intersections - flow dividers solenoid

Code	Electronic proportional flow controls	
	Type	Voltage
<b>FDEN</b>	<b>Flow Divider Electronic</b>	
<b>12</b>		<b>12VDC</b>
<b>24</b>		<b>24VDC</b>

Example :

FDEN 12 = Proportional flow divider 12VDC

## Intersections - mid inlets

Code	Mid inlets			
	Type	Type	Relief valve	Setting in bar
<b>MI</b>	<b>Mid Inlet</b>			
<b>T</b>		<b>separate Tank port</b>		
<b>PCO</b>		<b>Pressure Carry Over</b>		
<b>R</b>			<b>Relief valve</b>	
<b>XXX</b>				<b>XXX pressure in bar</b>

Examples :

MIT R170 = Mid inlet with separate tank port, R/V set 170b.

MI PCO R110 = Mid inlet with PCO link, R/V set 110b.

## Intersections - special plates

Code	Special intersections
	Type
<b>SP5</b>	<b>Spacer Plate 5mm</b>
<b>S19</b>	<b>Support 19mm with mountings</b>
<b>SC</b>	<b>Series Connector</b>
<b>SPP</b>	<b>Series Parallel Plate</b>
<b>SPH</b>	<b>Series Parallel Half plate</b>

## Ancillaries - service line relief

Code	Service Line Relief				
	Type	Relief valve	Anti Cavitation	Relief valve	Anti Cavitation
<b>SLR</b>	<b>S</b> ervice <b>L</b> ine <b>R</b> elief				
<b>XXX</b>		<b>XXX</b> pressure in bar		<b>XXX</b> pressure in bar	
<b>AC</b>			<b>A</b> nti <b>C</b> av		<b>A</b> nti <b>C</b> av
		<b>A Port</b>		<b>B Port</b>	

Examples :

SLR 140/140 = 140b A port / 140b B port

SLR 0/100 = No SLR A port / 100b B port

SLR 35AC/35AC = Anti cav and SLR 35b A port / Anti cav and SLR 35b B port

SLR 100/AC = 100b A port / Anti Cav B port

## Ancillaries - pilot check valves

Code	Pilot Check Valve	
	Type	Relief valve
<b>PC</b>	<b>P</b> ilot <b>C</b> heck	
<b>A</b>		<b>A</b> port only
<b>B</b>		<b>B</b> port only
<b>D</b>		<b>D</b> ouble acting
<b>1/2A</b>		<b>D</b> ouble acting - <b>A</b> port only checked
<b>1/2B</b>		<b>D</b> ouble acting - <b>B</b> port only checked

Example :

PC D = Pilot check valve, double acting.

## Ancillaries - cross-line relief valves

Code	Cross Line Relief	
	Type	Relief valve
<b>XLR</b>	<b>X</b> Line <b>R</b> elief	
<b>XXX</b>		<b>XXX</b> pressure in bar

Example :

XLR 120 = Cross line relief 120b

## Ancillaries - solenoid 4 position

Code	Solenoid four position manifold	
	Type	Voltage
<b>4</b>	<b>s</b> olenoid <b>4</b> position float	
<b>12</b>		<b>12</b> VDC
<b>24</b>		<b>24</b> VDC

Example :

4 24 = Solenoid 4 position, 24 VDC

**Spool Identification (not to scale)**

**V3-100 Manual**

- Diagram of a double acting cylinder spool. It features a central spool with four lands and four grooves, allowing for bidirectional flow between the two cylinder ports and the tank. The spool is shown in a cross-sectional view with a tapered end.
- D**

Double acting cylinder spool  
Part no. V3011  
Code 'D'
- Diagram of a single acting cylinder spool for the 'A' port. It has a central spool with three lands and three grooves, allowing for flow from the tank to the cylinder port and back to the tank. The spool is shown in a cross-sectional view with a tapered end.
- A**

Single acting cylinder spool 'A' port  
Part no. V3012  
Code 'A'
- Diagram of a single acting cylinder spool for the 'B' port. It has a central spool with three lands and three grooves, allowing for flow from the tank to the cylinder port and back to the tank. The spool is shown in a cross-sectional view with a tapered end.
- B**

Single acting cylinder spool 'B' port  
Part no. V3013  
Code 'B'
- Diagram of a double acting motor spool. It features a central spool with four lands and four grooves, allowing for bidirectional flow between the two motor ports and the tank. The spool is shown in a cross-sectional view with a tapered end.
- M**

Double acting motor spool  
Part no. V3014  
Code 'M'
- Diagram of a 4 position float spool. It features a central spool with four lands and four grooves, allowing for bidirectional flow between the two cylinder ports and the tank. The spool is shown in a cross-sectional view with a tapered end.
- 4**

4 Position float spool  
Part no. V3067  
Code '4'

**V3-100 Solenoid**

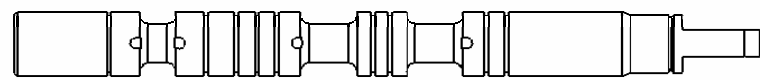
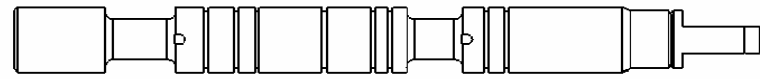
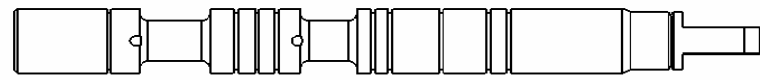




- Diagram of a double acting cylinder spool. It features a central spool with four lands and four grooves, allowing for bidirectional flow between the two cylinder ports and the tank. The spool is shown in a cross-sectional view with a tapered end.
- D**

Double acting cylinder spool  
Part no. V3211  
Code 'D'
- Diagram of a single acting cylinder spool for the 'A' port. It has a central spool with three lands and three grooves, allowing for flow from the tank to the cylinder port and back to the tank. The spool is shown in a cross-sectional view with a tapered end.
- A**

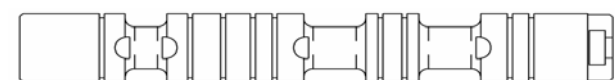



Single acting cylinder spool 'A' port  
Part no. V3212  
Code 'A'
- Diagram of a double acting motor spool. It features a central spool with four lands and four grooves, allowing for bidirectional flow between the two motor ports and the tank. The spool is shown in a cross-sectional view with a tapered end.
- M**

Double acting motor spool  
Part no. V3214  
Code 'M'

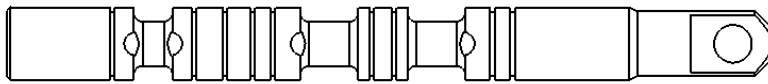
**V4-40 Manual**

	<b>D</b>	Double acting cylinder spool Part no. V4101 Code 'D'
	<b>A</b>	Single acting cylinder spool 'A' port Part no. V4102 Code 'A'
	<b>B</b>	Single acting cylinder spool 'B' port Part no. V4103 Code 'B'
	<b>M</b>	Double acting motor spool Part no. V4104 Code 'M'
	<b>MF</b>	Double acting motor spool - fine metering Part no. V4105 Code 'MF'
	<b>4</b>	4 Position float spool Part no. V4106 Code '4'
	<b>K</b>	Double acting cylinder spool - fine metering Part no. V4114 Code 'K'

**V5-60 Solenoid**

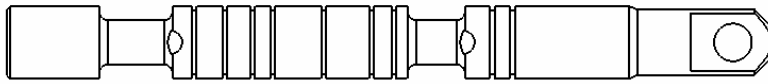
	<b>D</b>	Double acting cylinder spool Part no. V5140 Code 'D'
	<b>B</b>	Single acting cylinder spool 'A' port Part no. V5141 Code ' B'
	<b>M</b>	Single acting cylinder spool 'B' port Part no. V5142 Code 'M'
	<b>A</b>	Double acting motor spool Part no. V5144 Code 'A'

## V5-60 Manual



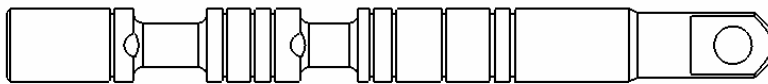
**D**

Double acting cylinder spool  
Part no. V5120  
Code 'D'



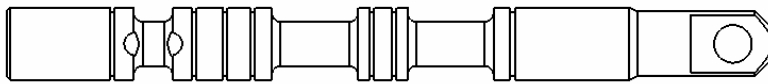
**A**

Single acting cylinder spool 'A' port  
Part no. V5121  
Code 'A'



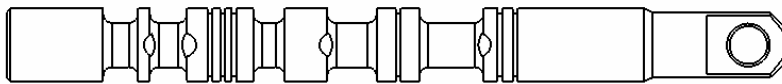
**B**

Single acting cylinder spool 'B' port  
Part no. V5122  
Code 'B'



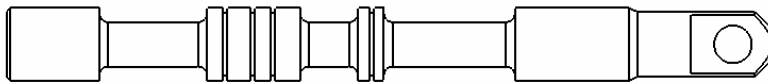
**M**

Double acting motor spool  
Part no. V5123  
Code 'M'



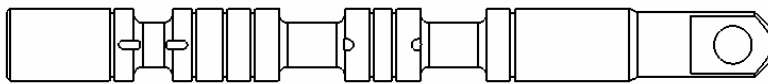
**4**

4 Position float spool  
Part no. V5124  
Code '4'



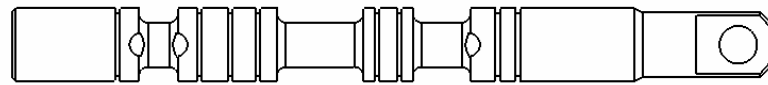
**P**

Special unloading spool  
Part no. V5128  
Code 'P'  
(Dead mans lever)



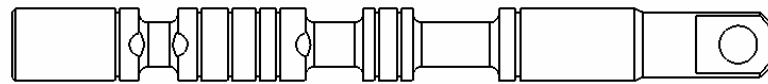
**MF**

Double acting motor spool  
- fine metering  
Part no. V5131  
Code 'MF'



**DM**

Double acting half motor spool 'B' port  
Part no. V5136  
Code 'DM'  
'A' port closed, 'B' port open to return



**MD**

Double acting half motor spool 'A' port  
Part no. V5137  
Code 'MD'  
'B' port closed, 'A' port open to return

## Cartridge identification

### Solenoid cartridges

Red dot  
on end



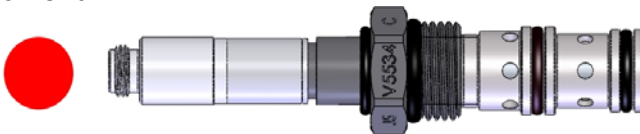
Solenoid cartridge Normally Closed  
Used in: Solenoid spool section  
Part no. V5 V5533-C

Yellow dot  
on end



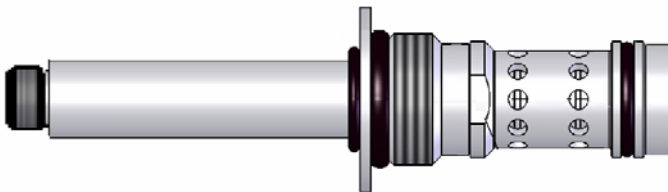
Solenoid cartridge Normally Open  
Used in: Solenoid unloader section  
Part no. V5 V5533-O

Red dot  
on end



Solenoid cartridge Normally Closed  
Used in: V5-60 4xx solenoid 4th position  
Part no. V5534-C

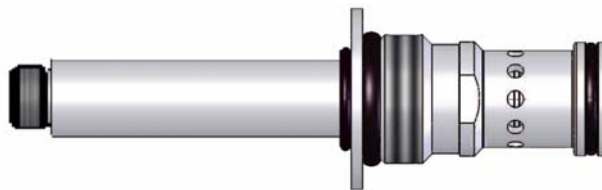
### Orifice cartridges



Orifice cartridge 60 L/min priority  
Used in: FDEN Proportional flow divider  
Part no. V5 V5396



Orifice cartridge 35 L/min priority  
Used in: FCEN Proportional flow control  
Part no. V5 V5290

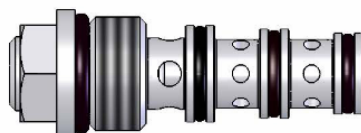


Orifice cartridge 35 L/min priority  
Used in: FCE Proportional flow control  
FDE Proportional flow divider  
Part no. V5 V5347

### Flow divider cartridges



60Lpm flow divider cartridge  
Used in: FDEN Proportional flow divider  
Part no. V5 V53931



flow divider cartridge  
Used in: FDE proportional flow divider  
Part no. V5 V53070

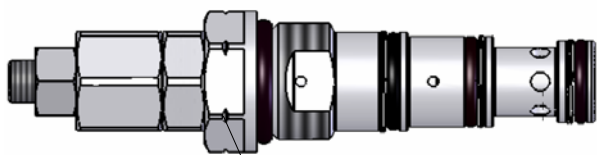


## Pilot pressurising cartridge



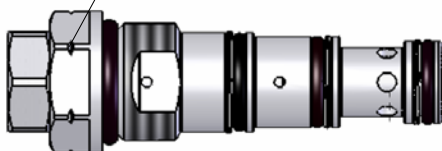
Pilot pressurising valve cartridge  
Used in: V3-100, V4-40 and V5-60 solenoid sections  
Part no. V5 V5410

## Unloader cartridges



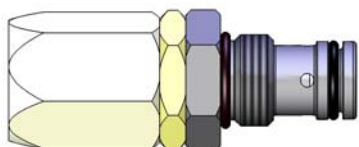
Unloader bypass cartridge with relief valve  
Used in: Solenoid unloader section  
Part no. V5 V53413

Note identification marks on hex



Unloader bypass cartridge  
Used in: Solenoid unloader section  
Part no. V5 V53414

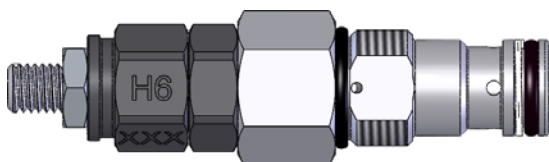
## Relief valve cartridges



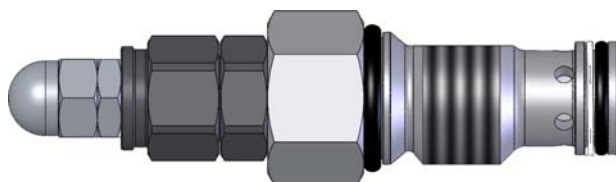
Relief valve cartridge - direct acting  
Used in: V1835 line mounted variants.  
Part no. V1835C



Relief valve cartridge - direct acting  
Used in: RV60 D variants, V4-40 & V5-60  
Part no. RV60 DSN XXX XX



Relief valve cartridge - pilot operated  
Used in: RV60 P variants, V4-40 & V5-60  
Part no. RV60 PSN XXX XX



Relief valve cartridge - pilot operated  
Used in: RV100 P variants and V3-100  
Part no. RV100 PSN XXX XX

## Flow control cartridges 60 L/min

60 L/min Flow control needle cartridge  
Used in: V4-40, and V5-60 flow control sections

Standard needle  
Part no. V5 V53760

No shut off (Code O)  
Part no. V5 V53761

30 Lpm (Code L)  
Part no. V5 V53762

Fine (Code F)  
Part no. V5 V53763

Flow control needle cartridge  
Used in: FC60 in-line flow controls  
Standard needle  
Part no. V5 V53764

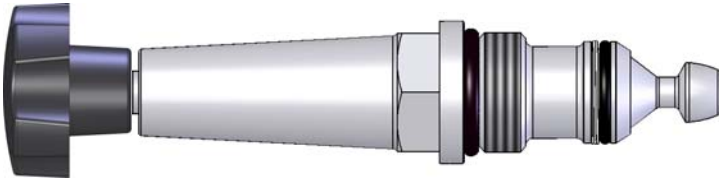
Fine  
Code F  
Part no. V53765

30 L/min  
Code L  
Part no. V5 V53766

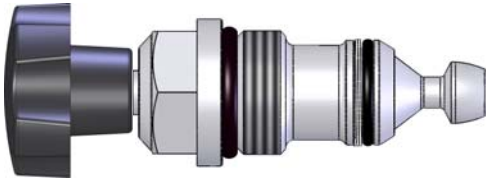
Flow control bypass cartridge with relief valve  
Used in: FCN RXXX and FC60 RXXX  
flow controls  
Part no. V5 V53411

Flow control bypass cartridge  
Used in: FCN and FC60 flow controls  
Part no. V5 V53412

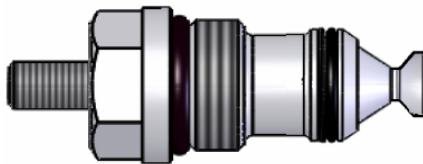
## Flow control cartridges 100 L/min



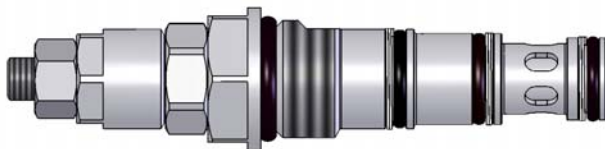
100 L/min Flow control needle cartridge  
Used in: V3-100 flow control sections  
Part no. V5 V53311



100 L/min Flow control needle cartridge  
Used in: FC100 in-line flow controls  
Part no. V5 V53312



64L/min Flow control needle cartridge  
Used in: FC100 sectional flow controls  
Part no. V5 V53767



Flow control bypass cartridge with relief valve  
Used in: V3 FCN RXXX and FC100 RXXX  
Part no. V5 V53381

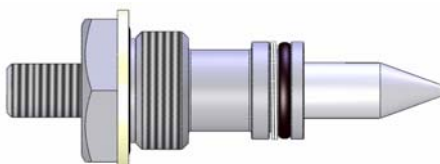


Flow control bypass cartridge  
Used in: V3 FCN and FC100 flow control  
Part no. V5 V53382

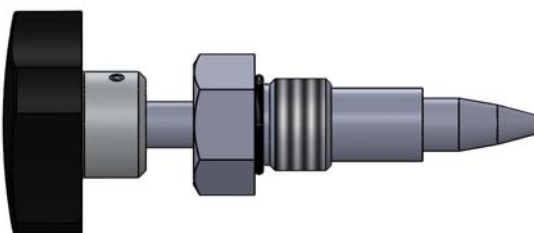
## Flow control cartridges - old style



flow control needle cartridge  
Used in: V1729K line mounted flow control  
Part no. V1729-KIT

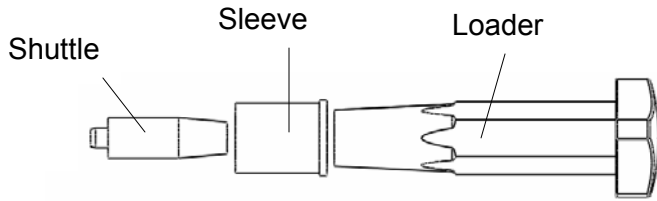


flow control needle cartridge  
Used in: V4-40 and V5-60 flow control sections  
pre-2009  
Part no. V5 FCK KIT

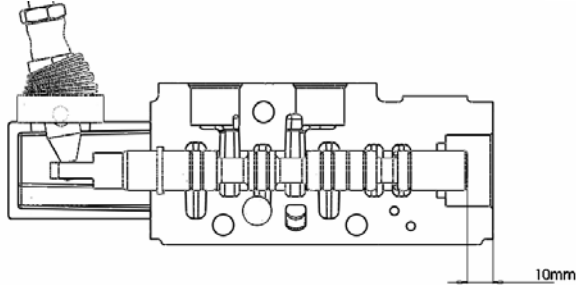


flow control needle cartridge  
Used in: V3-100 flow controls  
Part no. V3 FCK KIT

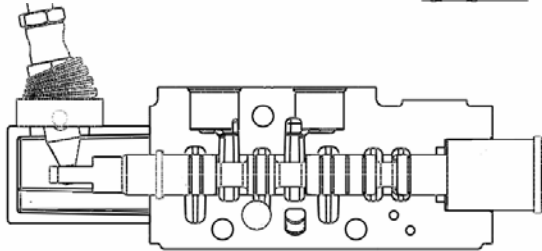
## V4-40/V5-60 Rear spool seal installation - manual sections only



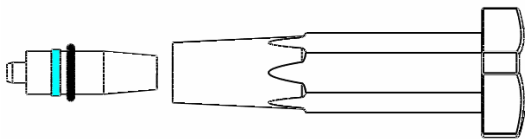
The rear spool seal is installed using Special tool ST1041.



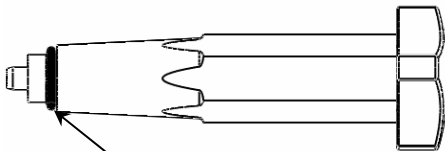
Position the spool as shown.



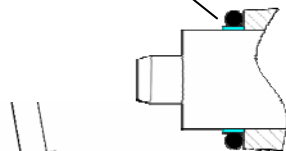
Insert the sleeve fully into the valve body



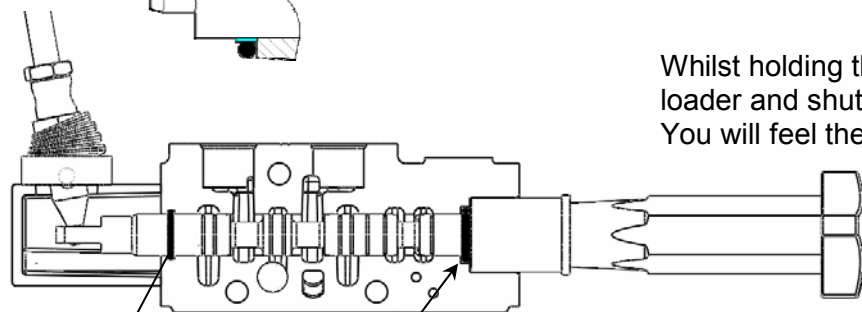
Load the slip ring and O ring onto the shuttle



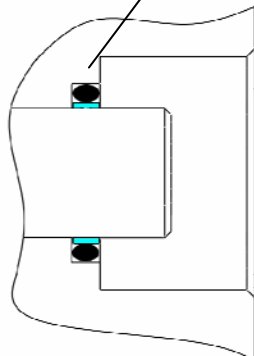
Slide the shuttle into the loader



Whilst holding the spool in position slide the loader and shuttle into the sleeve. You will feel the seals 'click' into place.



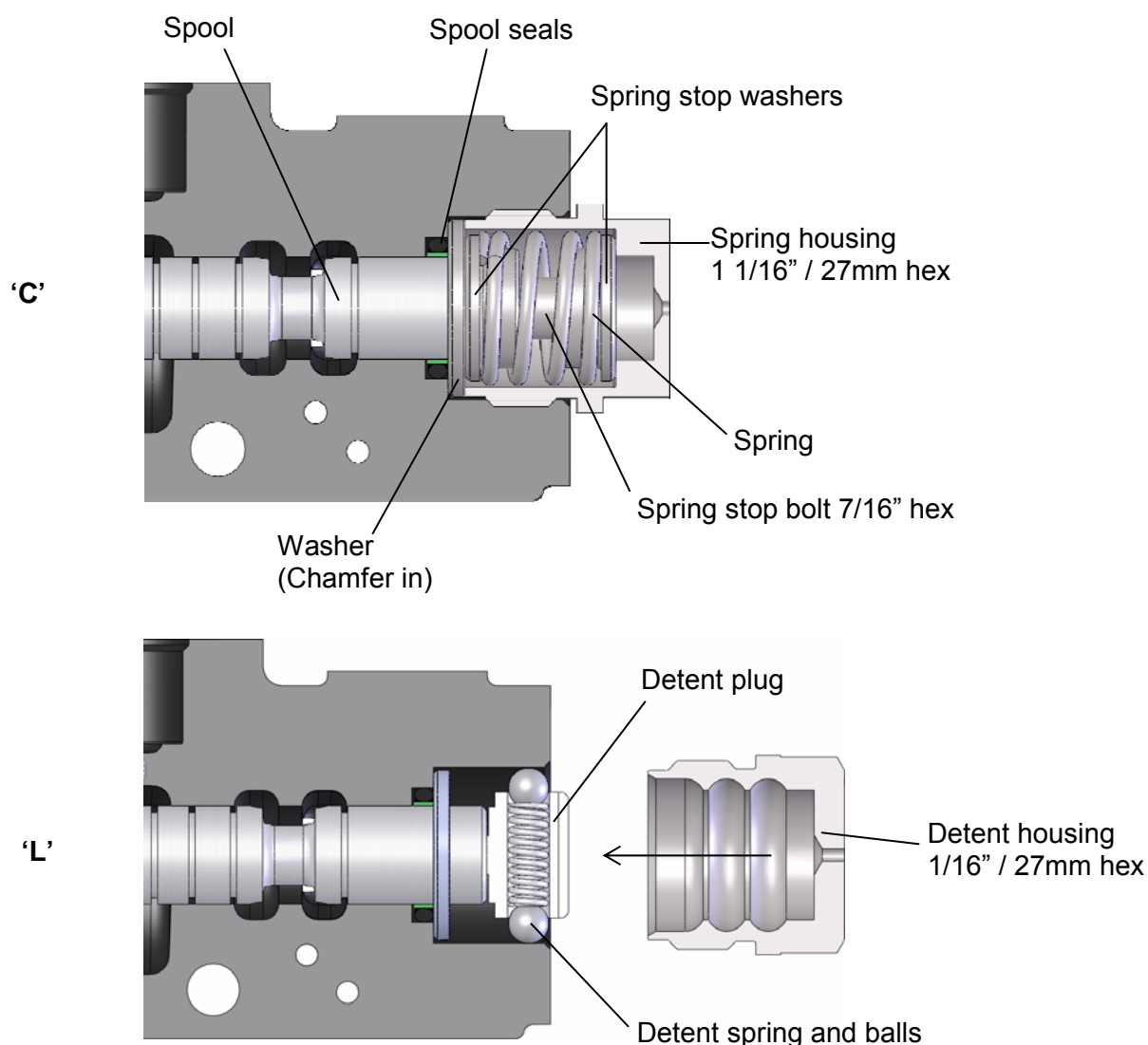
O ring



Correctly fitted seals.  
Do not move the spool!

## Spring / detent mechanism swap instructions

Ref. page 12 for torque tightening figures



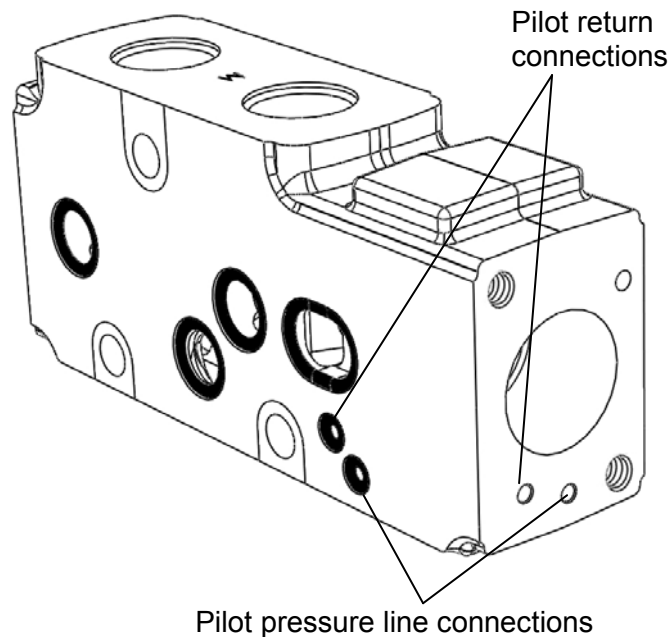
- 1) Remove the spring housing.
- 2) Undo and remove the spring stop bolt, spring and 2 spring stops.
- 3) Do not remove the spool, washer or spool seals
- 4) Screw in the detent plug—secure with Loctite 222 or equivalent.
- 5) Assemble the spring and balls as shown.
- 6) Whilst keeping the balls in place with your fingers, operate the lever so as to move the spool in until the balls are held by the thread in the valve body. Only move the spool enough to keep the balls in place.
- 7) Apply grease to the inside of the detent housing.  
Without moving the lever screw in the detent housing

## Solenoid valve trouble shooting

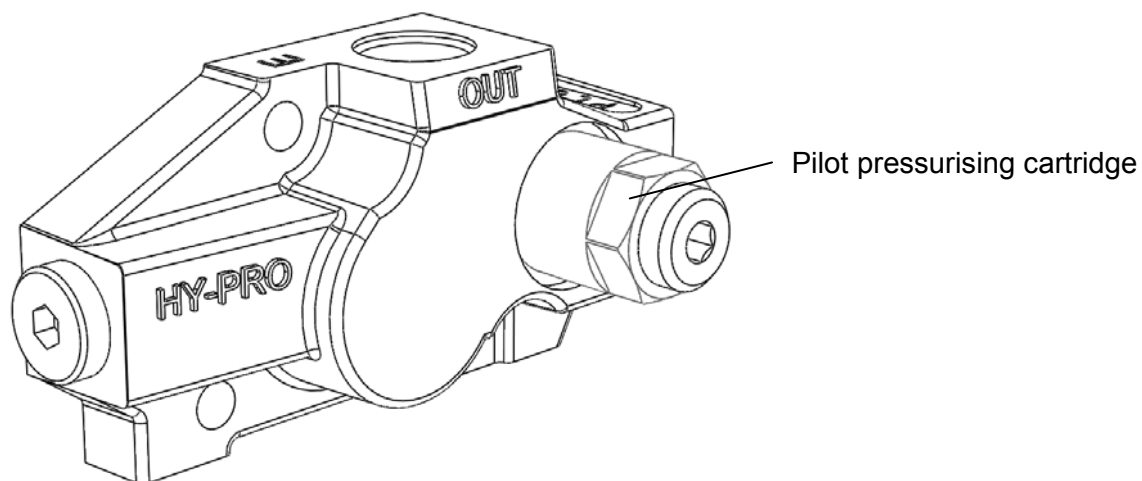
### Design, function and cautions.

A simple rugged and reliable system that, when installed and commissioned correctly, will provide safe trouble free service.

The design uses a pilot circuit fed from the Inlet cover and drained to the Outlet. A manifold with two solenoid cartridges is bolted to the end of each valve section which is internally connected to the pilot lines and main spool ends.

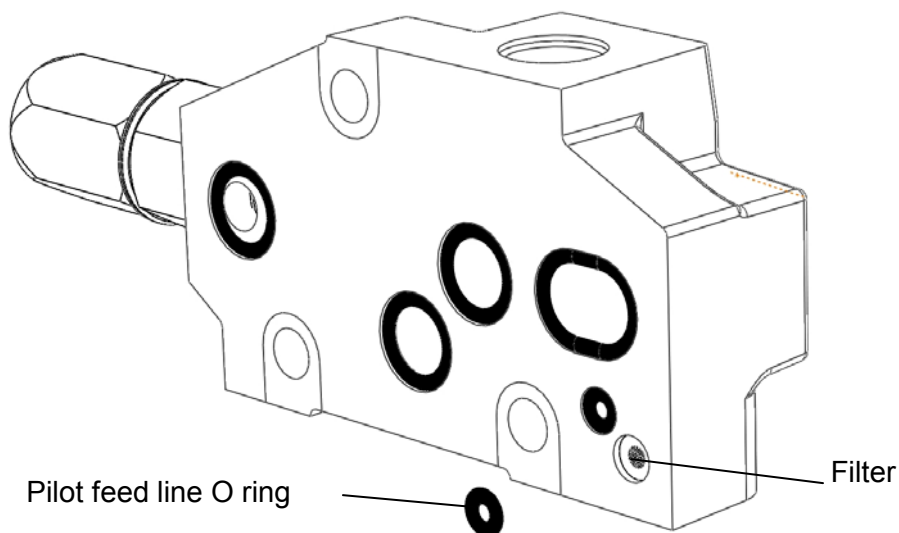


A sliding piston type cartridge valve is located in the Outlet cover at the through centre gallery connection to provide the pilot pressure. When a cartridge is energised it switches the pilot pressure to the selected end of the main spool to operate it, and drains it via the return line to allow it to spring centre to neutral when de-energised.

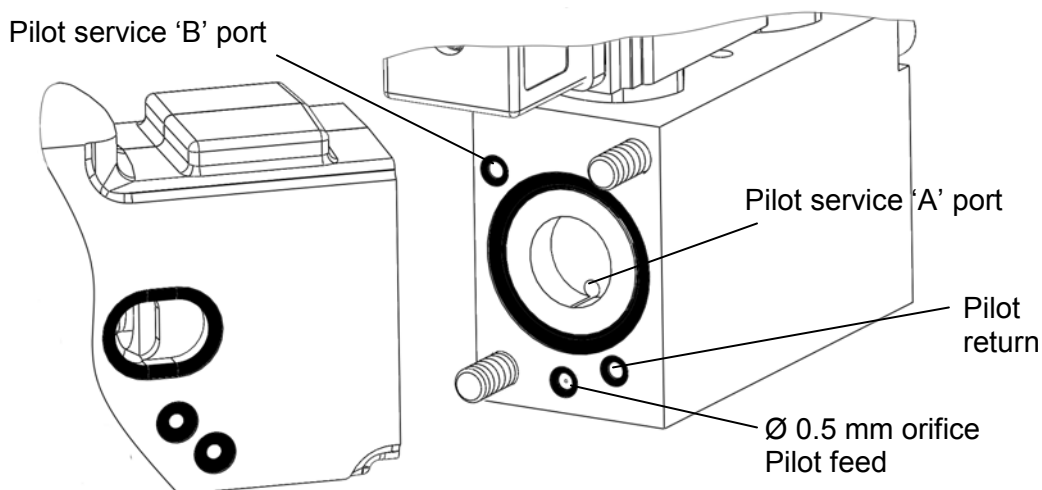


When the main spool moves across and the through centre closes and the pressurising valve is no longer in the circuit and the service port pressure holds the main spool across.

There is a small filter in the Inlet cover (under the pilot feed line O ring) to prevent debris entering the pilot system.



Each manifold has a press fit plug in the feed connection with a  $\varnothing 0.5$  mm orifice to dampen the main spool motion.



Solenoid operated sections are available with manual override levers, which can also be retro fitted as a kit. Please note that due to the spool end area imbalance which occurs when overrides are fitted, the return line pressure must not exceed 18 bar at maximum operating flow and minimum fluid temperature condition or self-operation may occur.

The solenoid coils are continuously rated and can reach temperatures of  $>100^{\circ}\text{C}$ , appropriate safety guarding / warning signage must be provided.

## Trouble Shooting

Problems can occur on initial start-up or after a period of service. It is important to establish the history.

An assumed valve malfunction may be a symptom so before investigating the valve, basic hydraulic system checks should be made on oil level, condition, pump performance, filters, operating temperature etc. and likewise with the electrical / electronic control system.

Is the valve connected up properly? Where is the inlet hose connected?

If it is a new system the hose / reservoir / filter sizes at maximum flow rate must be to industry recommendations and specifications.

The National Fluid Power Centre states "It is estimated that over 80% of all failures in hydraulic systems are due to contamination of the fluid".

In the following charts faults possibly due to contamination are noted in red. However before dismantling the valve investigate and eliminate all other potential causes based on an assessment of likelihood / ease of check.

If valve components are removed be sure to re-assemble correctly and torque tighten to the specified value – see page 12

**Important! Appropriate safety precautions must be taken to ensure the machine and hydraulic system are safe before work commences.**

## Principles of Hydraulic Systems\*

- 1) Flow makes it go.
- 2) Pressure provides the push.
- 3) Fluid in a circuit will take the path of least resistance.
- 4) Pressure is a measure on the resistance to flow.
- 5) For oil to flow in any system there must always be a pressure difference.
- 6) The greater the pressure difference the greater the flow potential.
- 7) When oil flows from a high pressure to a low pressure, without doing work, heat is generated.

\*Courtesy of the NFPC

Fault	Cause	Remedy
No functions at all	No pump flow	Investigate and rectify
	No pilot pressure. Pilot pressurising valve stuck / jammed open.	Remove and check. Piston should move freely against the spring. Clean or replace.
	No power to the coils.	Check the voltage at the solenoid plug. Investigate and rectify.
	Low voltage.	Check the voltage at the solenoid plug. Must be 75% minimum of the coil rating. Investigate and rectify.



Fault	Cause	Remedy
One section failed – both directions	Damper orifice blocked. No pilot feed to the main spool.	Remove the manifold, examine and clean the damper orifice.
	Main spool stuck.	Remove solenoid manifold to access the main spool and check for free movement. Clean and replace.
	No power to the coils.	Check the voltage at the solenoid plug. Investigate and rectify.

Fault	Cause	Remedy
One section failed - one direction	Coil open circuit.	Check continuity / resistance and replace if faulty. 12vDC = 6Ω +/- 10% 24vDC = 24Ω +/- 10%
	Pilot cartridge spool jammed – contamination or damage.	Remove, check operation (audible 'click' when energised with spool movement). Clean / replace if faulty.

Fault	Cause	Remedy
Self-operation / hesitation of manual override(s). Especially when the system is cold	High return line pressure – must not exceed 18 bar at maximum flow / minimum temperature conditions. Check at Outlet cover port.  1) Inadequate hose diameter for flow / length. 2) Return line filter inadequate for flow or blocked 3) QR connectors generating pressure.	1) Increase hose size. 2) Increase filter size or replace if blocked 3) Increase QR size (or eliminate).

Fault	Cause	Remedy
Operates cold, becomes intermittent with increasing temperature.	Low pilot pressure. Pilot pressurising valve partially jammed open or sticking.	Remove and check. Piston should move freely against the spring. Clean or replace.
	Borderline voltage. The coil efficiency will decrease with increasing temperature.	Check the voltage at the solenoid plug. Must be 75% minimum of the coil rating. Investigate and rectify.

Fault	Cause	Remedy
Jerky movements of actuators.	Intermittent loss of service port pressure due to actuator over run.	1) Use restrictors to maintain service port pressure. 2) Use over centre valves 3) Increase the flow.

Fault	Cause	Remedy
Partial or erratic spool / lever movement when machine is unloaded.	Loss of service port pressure due to low operating pressure.	1) Use restrictors to maintain service port pressure. 2) Increase the flow.

## Spool Stick and Hesitation

Spool stick or hesitation may occur when the operating parameters for the product are exceeded and / or because of other factors. Only the spring returns the spool to neutral, everything else opposes it. When the total factors opposing the spool centering exceed or equal the available spring force the spool will stick.

The following table is a guide to understanding and fault finding a spool stick problem, it is not unusual for several factors to be working together to cause this.

Hydraulic	Mechanical
P1 Inlet Pressure P2 Outlet Pressure P3, 4, 5 etc. Service Pressure Q1 Inlet Flow Q2, 3 4 etc. Service Port Return Flow	Spool actuators Lever assembly Damage, corrosion Modification Cables Excess friction  Spring centering mechanism Damage, corrosion  Body distortion - excess Temperature Pressure Stud torque Port adaptor torque  Mounting surface defects  Spool Seal friction - excess Temperature Pressure P1 and P2  Fluid contamination

Whilst every care is taken in the design (spool balancing grooves, body side face relief, metering cut outs) and in the manufacture (spool / bore surface finish and geometry, bore / spool clearance etc.) of the product, spool stick can occur for the external reasons listed in the table.

Spool stick is a symptom and the cause(s) needs to be identified and eliminated based on the table.

The stable bulk fluid temperature of a machine under normal operating conditions is an indicator of its health, if it exceeds normal limits the design of the system and performance of individual components needs to be investigated.

Factors to be considered in the investigation would be, 1) if it is a new system, or 2) a system that has been performing acceptably and a problem has developed.

The control valve recommended operating temperature range is limited by the O ring material and (standard commercial) hydraulic fluid rating.



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