



STEERING

Technical Information

SbXC steering valve

White is a leading global provider of
motor and steering solutions that power
the evolution of mobile and industrial
applications around the world.



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Key definitions and acronyms

SbXC	Product name – Steer-by-wire, Current-controlled
LSRV	Load sense relief valve
ECU	Electronic control unit
EH	Electrohydraulic
SBW	Steer-by-wire
I/O module	Input output module
Isolation valve (cut-off function)	Valve that blocks electrohydraulic steering flow from reaching the steer cylinders
Main spool	Proportional spool that controls gain, through notch design, of both meter-in and meter-out of steering flow
Mode select valve	Valve that directs pressure to open or close the isolation valve as well as the load reaction switching valve
Steering unit	Steering control unit (e.g. LAG or S10)
PWM	Pulse-width modulation
POCV	Pilot Operated Check Valve
DPCV	Direct Proportional Control Valve

Chapter 1

Introduction

Product overview

The SbXC is WHITE's current controlled electrohydraulic steering valve that can be paired with one of WHITE conventional steering control units to provide electro-hydraulic steering or standalone to provide steer-by-wire functionality. The SbXC valve provides mobile off-highway equipment OEMs with flexible electronically controlled hydraulic steering on their machines. Be it EH steering or pure SBW, the SbXC valve is an initial step towards autonomous steering on mobile off-highway equipment.

Features

User interface:

- Current-controlled electrohydraulic steering valve

Operating range:

- Rated flow: 30 l/min
- Flexible supply voltage: 12 VDC or 24 VDC

Benefits

Mounting & Integration Flexibility

- Available with a steering unit
- Bolt-on mounting directly to steering unit or remote installation via hoses
- Available in Open Center (OC) and Load Sensing (LS) variants to match existing machine hydraulics
- Single supplier for steering unit and electrohydraulic steering components, simplifying system integration
- Low entry barrier for OEMs and integrators due to simplicity of the system

Supports Multiple Steering Input Devices

- Supports conventional steering wheels and external steering controllers: GPS, Joystick, Multiple steering wheels
- Enables seamless integration of manual steering and automated steering functions

Supports configurable steering performance

- SbXC hardware architecture supports system-level steering performance configuration via external ECU and software
- Fast response due to direct-acting valve design

Safety

- Built-in cut-off / isolation valve for safe disengagement of automated steering
- PO valve supports prevention of unintended cylinder movement in fault conditions

- Fail-operational* functionality achieved in combination with conventional steering control units
 - * *Fail-operational refers to the ability of the steering system to maintain manual steering capability via a conventional steering control unit in the event of an electrohydraulic function shutdown.*

Easy Integration

- Works with any controller on the market using current or PWM outputs
- Easily paired with existing machine control systems, simplifying retrofit applications
- Integrated steering manifold includes key hydraulic functions required in steering systems, reducing external components

Direct-Acting Valve Advantages

- Fast response time compared to pilot-operated solutions
- Direct-acting valve architecture without proportional control valves improves robustness and contamination resistance
- Resistant to unstable hydraulic power supply
- Improved controllability at low flow rates
- Maintains steering functionality without pilot pressure, supporting service and fault scenarios

Serviceability & Customization

- High contamination resistance due to direct-acting valve architecture
- Easier replacement (modularity)
- Manifold design can be customized to customer-specific requirements, including additional integrated valve functions

Typical applications

- Material handling
 - Forklifts, cranes
- Construction
 - Rollers with autonomous steering
- Agriculture
 - Tractors, sprayers with GPS auto guidance

Chapter 2

Product overview

This chapter provides a functional description of the SbXC steering valve architectures introduced in Chapter 1, focusing on hydraulic flow paths and safety-related interactions.

Product introduction and functionality

The SbXC is an electrohydraulic valve used in steering systems. It consists of a direct-acting current controlled proportional valve (DPCV) mounted on a valve block. The valve block integrates an isolation solenoid valve (cut-off function) and optional additional hydraulic functions depending on the application configuration.

The DPCV controls steering flow without the use of proportional pilot valves, contributing to a simple and robust valve architecture. Pilot-operated check valves (POCV) are integrated in the valve block for load-holding and load sensing and safety-related functions.

When the auto-guidance function is activated, oil flow from the supply port (P-port) is routed through the isolation solenoid valve to the main stage valve (DPCV). The DPCV receives proportional current signals from an external ECU and directs the oil flow to the left or right steering cylinder ports (L- or R-port) as required, while return flow is directed to the tank port (T-port).

For safety-related system behavior, manual steering input (from Steering Unit) during SbXC operation generates a pressure signal at the PX ports. This signal can be used to actuate an external pressure switch that interrupts current to the isolation solenoid valve, thereby isolating the electrohydraulic steering function and cutting off flow to the DPCV section.

The POCV elements located on the connections to the left and right cylinder ports prevent oil from escaping to tank through the DPCV section in the event of a spool jam or continued electrohydraulic actuation while the operator is steering manually. This supports maintenance of manual steering capability in fault and service scenarios.

System Architecture Overview

The following diagram shows a typical steering system architecture using the SbXC steering valve in combination with an external electronic control unit (ECU), machine hydraulic supply, and steering actuators.

The diagram is intended to illustrate the functional interfaces and signal flow between system components. It defines the responsibility split between the SbXC valve and external system elements, including control logic, sensors, and safety-related functions.

Actual system configurations may vary depending on application, hydraulic architecture, and safety concept.

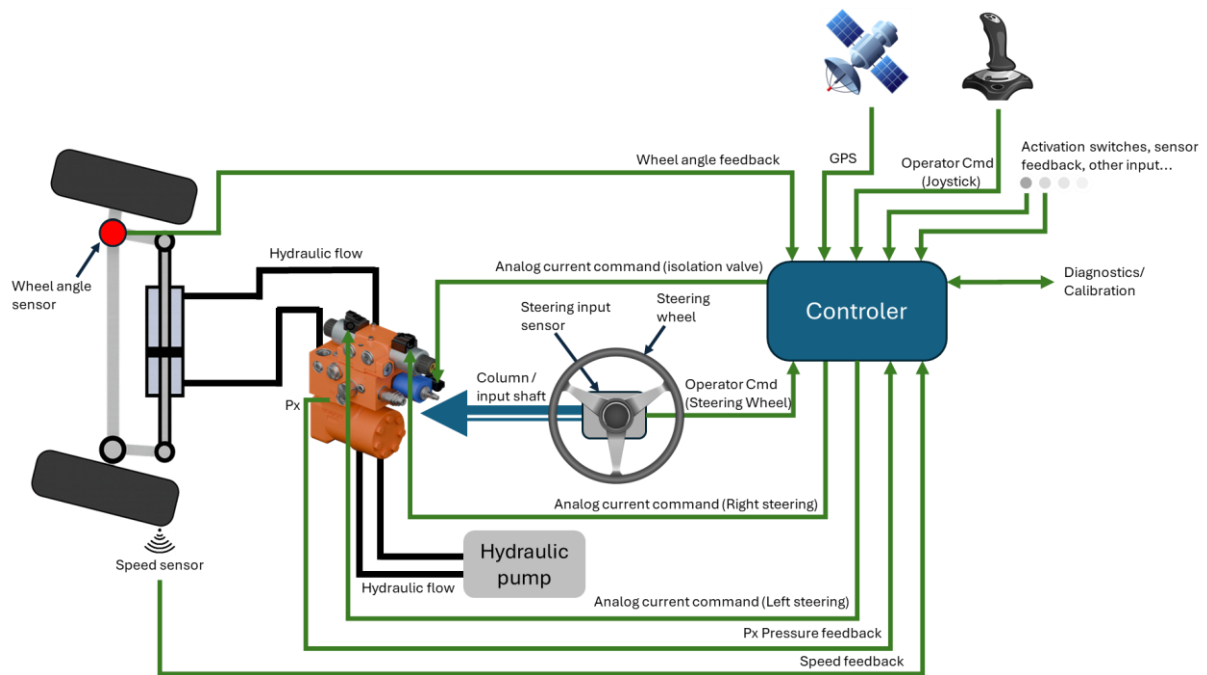


Figure 1: Typical SbXC steering system architecture with external ECU, hydraulic supply, steering actuators, and sensors

Supported Steering Control Functions

The SbXC steering valve enables electronically controlled hydraulic steering functions based on proportional current actuation.

The supported functions depend on the external controller and system architecture.

1. Proportional Steering Control

- Steering flow is proportional to the applied control current
- Enables smooth and continuous steering control in both directions
- Suitable for closed-loop control based on steering angle, articulation angle, or vehicle path

2. Steering Rate and Flow Control

- Steering speed can be controlled by limiting the command current
- Allows implementation of:
 - maximum steering rate
 - steering wheel lock to lock ratio
 - speed-dependent steering behavior
 - soft end-stop behavior near mechanical limits

3. Steering Damping and Stabilization Support

- Enables hydraulic damping of steering motion via controlled flow modulation
- Supports reduction of steering oscillations and overshoot
- Can be used to improve vehicle stability, especially at higher speeds or on uneven terrain

4. Support for Application-Specific Steering Functions

- Enables implementation of a wide range of steering functions depending on application requirements and system architecture
- Provides a flexible hydraulic interface adaptable to different steering concepts and control strategies
- Allows scalability from basic steering assistance to advanced electronically controlled steering functions

Scope of Responsibility

SbXC provides the hydraulic actuation interface for steering control.

All logic, supervision, and mode management are implemented by the external controller.

Safety Integration Capabilities

The SbXC steering valve is designed to support integration into machine-level safety architectures. The valve itself is not safety-rated, but provides predictable and monitorable behavior suitable for system-level safety functions.

Fail-Safe Behavior

- SbXC has built-in isolation valve that can cut-off the DPCV if any unwanted behaviour occurs
- In case of loss of electrical control signal (0 mA), the DPCV returns to a hydraulically neutral state
- No active steering command is generated, preventing unintended actuation
- The POCV ensures safe load-holding by locking the steering cylinders in place when no valid steering pressure is present

Fail detection options

- Px port for pressure sensor indicating the usage of the Steering Unit
- LS2 port for pressure sensor indicating operation of the SbXC

In the *System Architecture Overview* section, a typical steering architecture is presented. However, each specific application shall undergo a structured assessment of potential hazards and failure consequences in order to determine appropriate safety measures.

Safety analysis tools such as FMEA (IEC 61508) or Hazard and Risk Analysis in accordance with ISO 12100 and EN 13849 should be applied to identify and evaluate possible failure modes and to define safety requirements in compliance with applicable machine directives.

Application options

The SbXC is designed to control steering functions in machines from the following areas of application:

- Agricultural vehicles
- Autonomous and electric vehicles
- Construction and mining vehicles

The SbXC is suitable for both new machine designs and retrofit applications, where integration with existing steering and machine control systems is required.

The manufacturer must be consulted if the SbXC is to be used in an application other than those listed above. The SbXC steering valve is designed to be bolted to a secondary hydraulic component that interfaces with steering unit-style ports ("P," "T," "R," and "L"), or it can be used in a steer-by-wire configuration without any secondary steering component.

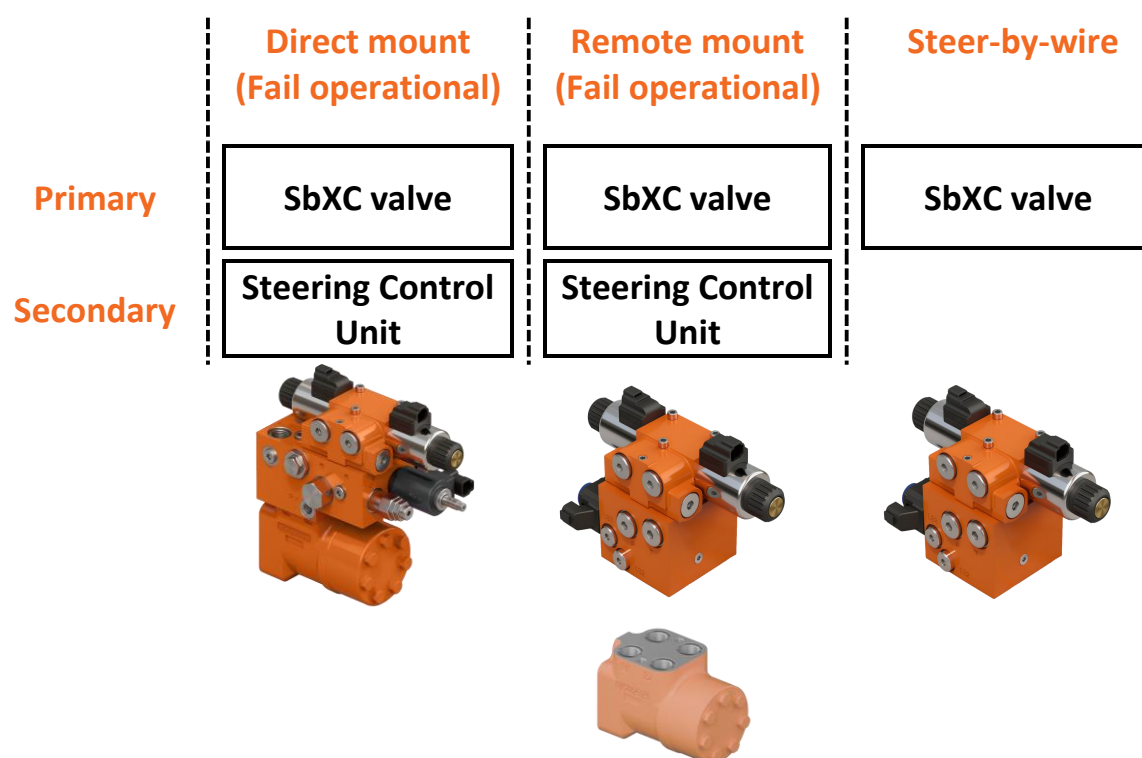


Figure 2 Three common SbXC options

Direct mount - Fail-operational Electrohydraulic (EH) Steering

An electrohydraulic (EH) steering system uses the SbXC in parallel with a steering control unit. In an EH architecture, the SbXC valve can be mounted directly on top of the steering unit or remotely mounted and coupled with hydraulic hoses. Advantages of this architecture are:

- A fail-operational system
- A traditional operator steering and interface

The hazard analysis of the application should indicate if a fail-operational system is appropriate. This type of architecture would allow for the electro-hydraulic portion of the steering system to be isolated when a safety function is activated by way of the integrated isolation valve. In the event of the SbXC safety function activation, the steering control unit remains functional.

In an EH steering system, the SbXC flow can be provided in parallel to provide superimposed flow capability or individually when coupled with an additional input device such as a joystick. Such an architecture is advantageous for applications that require that an operator always be able to steer the vehicle using a physical steering wheel (e.g. tractors). This solution can be in open center or load sensing version.

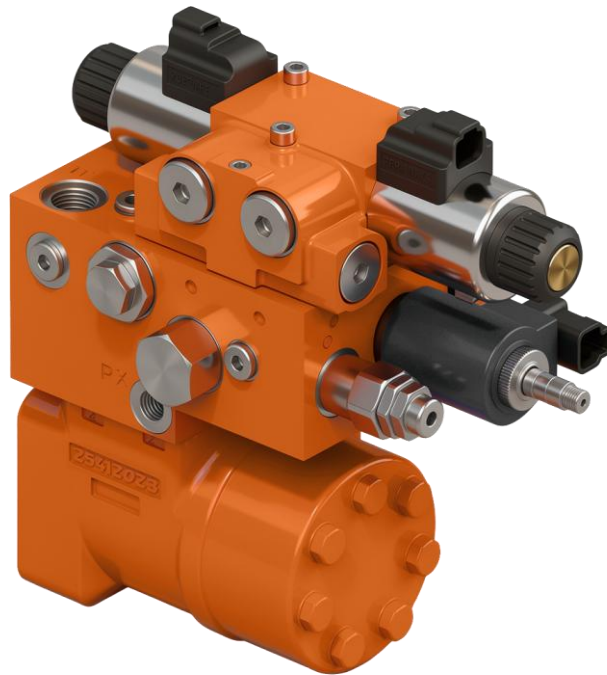


Figure 3: SbXC Electrohydraulic (EH)

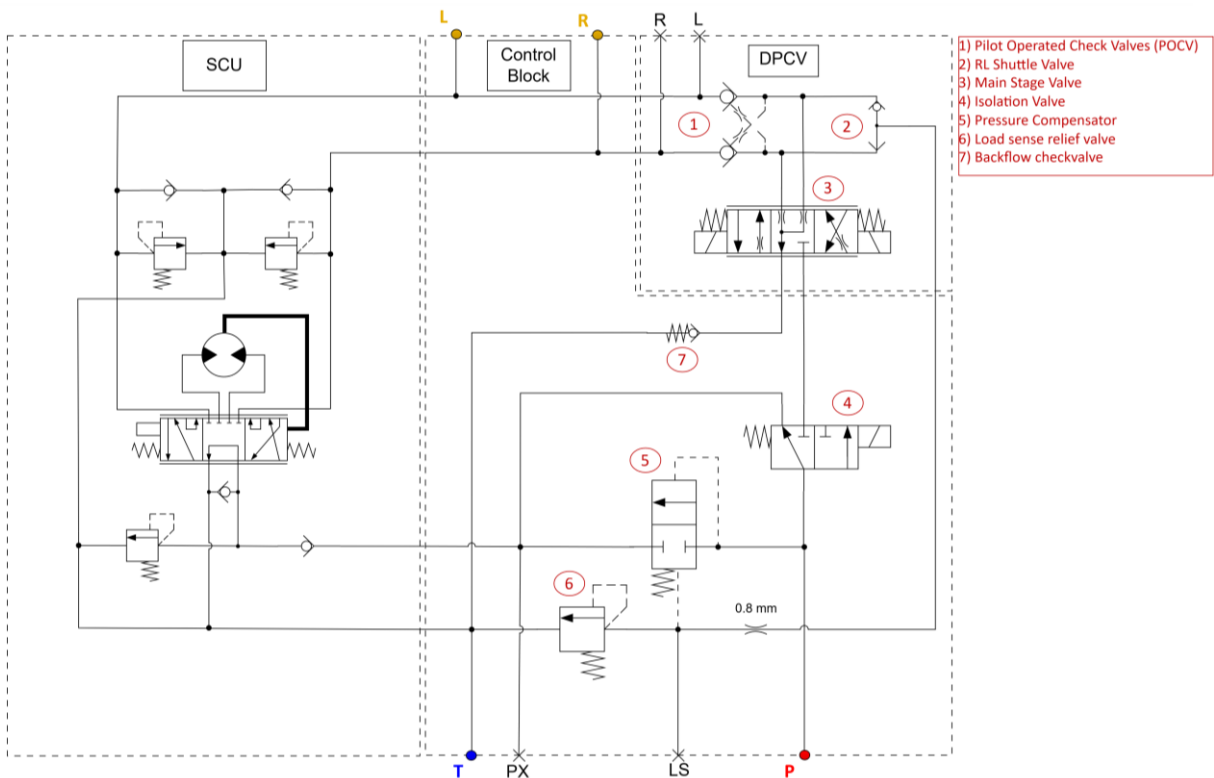


Figure 4: SbXC Electrohydraulic circuit; Open Center version

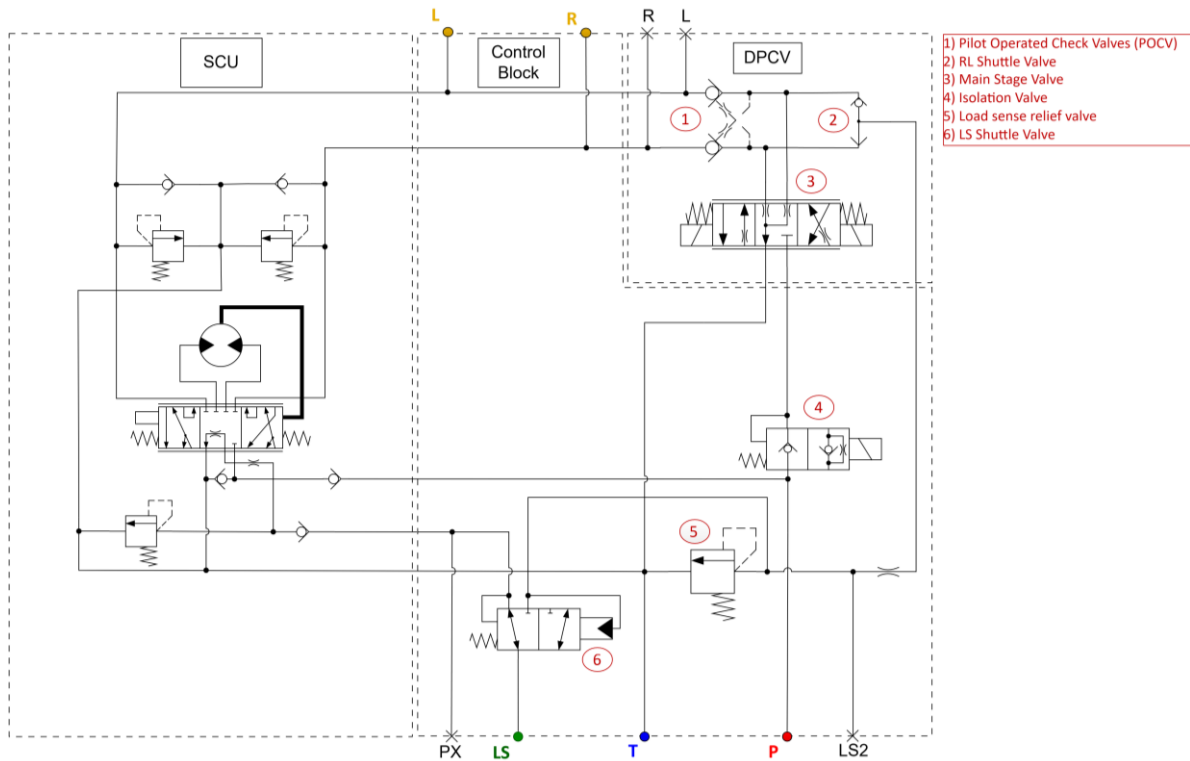


Figure 5: SbXC Electrohydraulic circuit; Load Sensing version

Remote mount

SbXC remotely connected to steering unit.

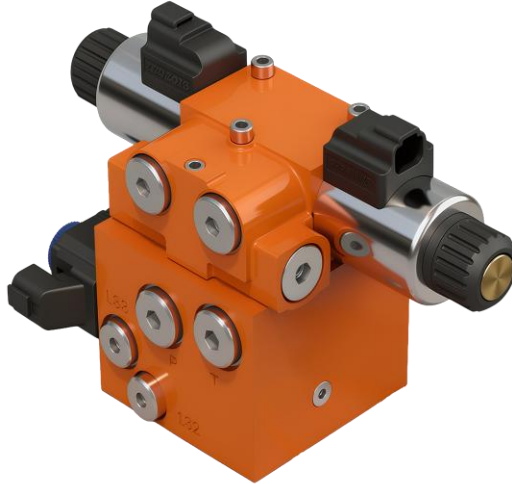


Figure 6: SbXC Remote mount

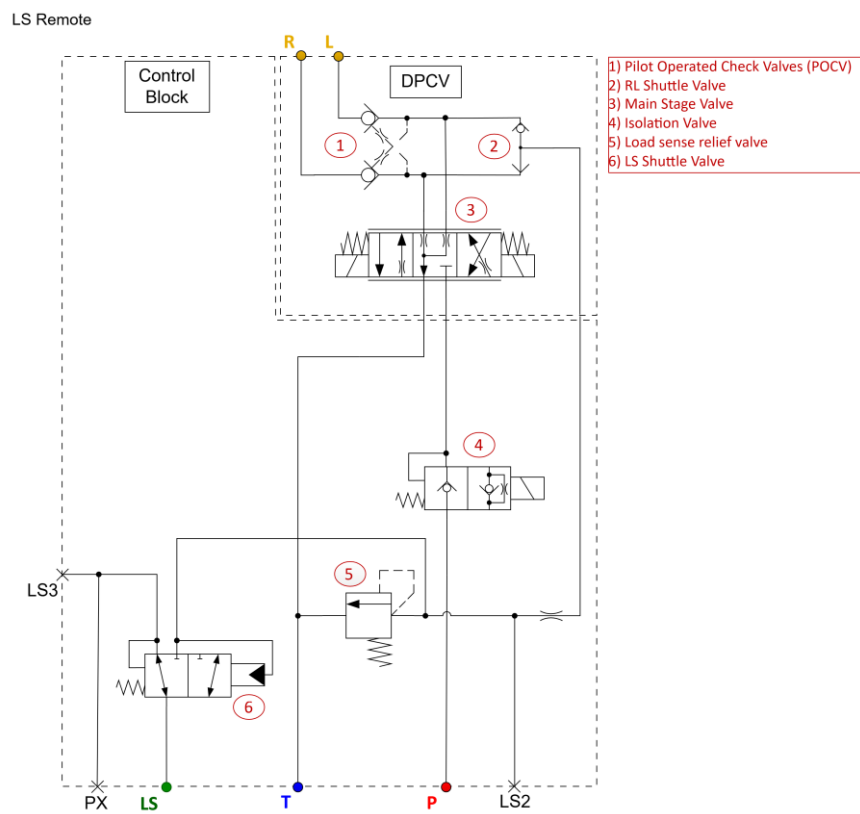


Figure 7: SbXC LS remote mount circuit

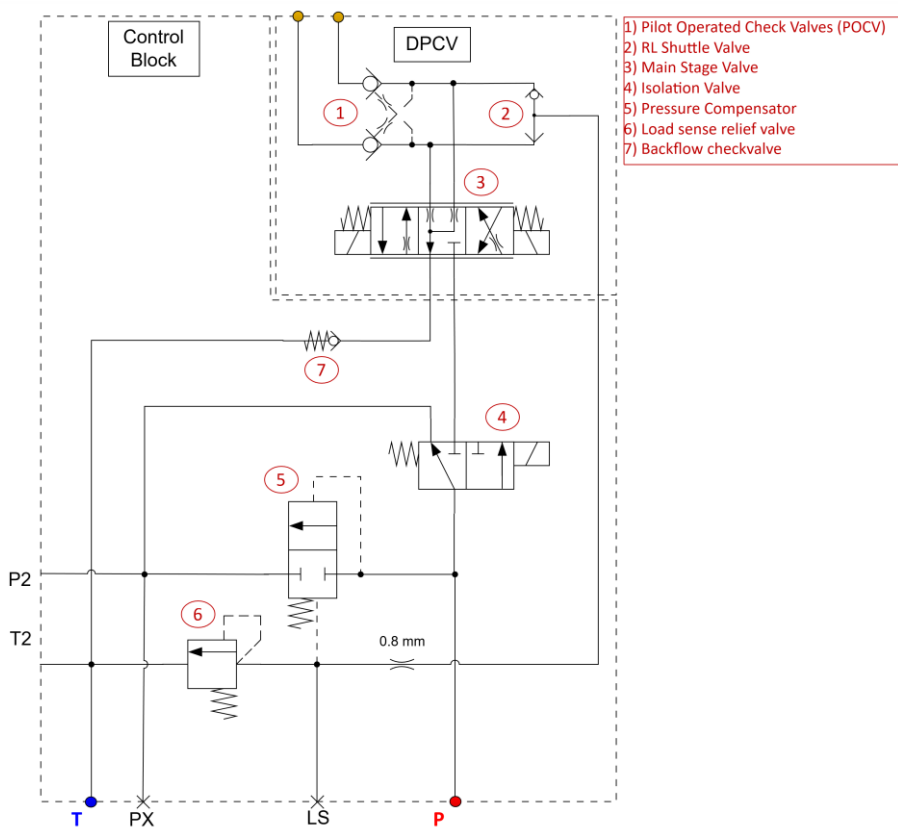


Figure 8: SbXC ON remote mount circuit

Standalone SbXC

A steer-by-wire steering system uses the SbXC valve without any additional steering valves. Essentially, it's the same version as the SbXC remote mount, but without a connected steering unit.

Advantages of this architecture are:

- Flexible mounting location
- Reduction of in-cab noise
- Flexible input device sensors: steering wheel, joystick, mini-steering wheel
- Lower cost than redundant steering systems

The hazard analysis of the application should indicate if a steer-by-wire system is appropriate.

Chapter 3

SbXC Valve Details

SbXC Valve Details

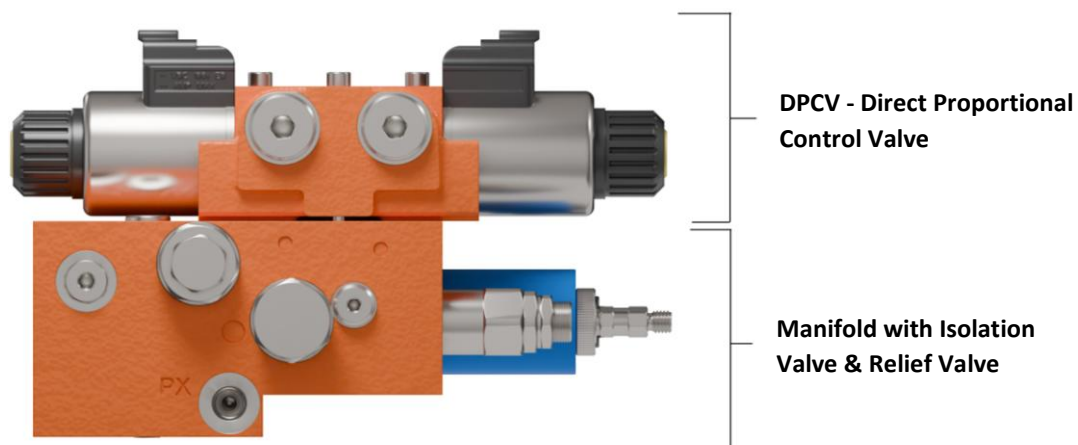


Figure 9: SbXC valve details

Technical data and specifications

Pressures

Rated inlet port P	190 bar
Max work ports L, R	230 bar
Max tank port T	20 bar

Flow

SbXC max flow	30 L/min (7.9 gal/min)
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Port type

P	M22 x 1,5 M18x1,5 3/4-16 INF (SAE-8) O-Ring Ports G 1/2" (BSP) Straight Thread Ports
L, R, T	M18 x 1,5 3/4-16 INF (SAE-8) O-Ring Ports G 1/2" (BSP) Straight Thread Ports
Px	7/16"- 20 UNF (SAE-4) O-Ring Ports M12x1,5 G 1/4" (BSP) Straight Thread Ports
LS, LS2, LS3	7/16-20 UNF (SAE-4) O-Ring Ports M12x1,5 G 1/4" (BSP) Straight Thread Ports

Temperature*

Standard oil (operating)*	-20 to 80 °C
Ambient (operating)	-20 to 80 °C

Viscosity

Recommended	12-85 cSt
Minimum	12 cSt
Maximum	400 cSt

Filtration

ISO 4406	18/16/13
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Actuation command options

Main Stage Valve (DPCV)	PWM
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Electrical

Input voltage	12VDC or 24VDC
Power/Current consumption	Main Stage Valve (DPCV) – 20 W Nominal Isolation valve Solenoid – 26 W Nominal

Electrical interface connectors

Main Stage Valve (DPCV) connector	Deutsch connector: DT04-2P
Isolation Valve connector	Deutsch connector: DT04-2P

Weight

SbXC only (steer-by-wire)	7,6 kg
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Model code specification

Model code of an SbXC:

Position	1 - 4	5-6	7-8	9-10	11-12	13-15	16	17	18	19	20	21	22	23	24	25
Code	SbXC	30	RM	LS	01	190	B	B	B	B	B	B	A	A	A	1

Position	Feature	Code	Description
1,2,3,4	Product	SbXC	Product family
5,6	Nominal flow rating	12	12 l/min
		30	30 l/min
7,8	Mounting configuration	RM	Remote mounted to the steering unit
		BL	Directly mounted (bolt-on) to the LAG steering unit
		BS	Directly mounted (bolt-on) to the S10 steering unit
		SA	Standalone
9,10	Neutral circuit	LS	Load Sensing, Dynamic Signal
		OC	Open Center
11,12	Valve options	01	Load Sense Relief Valve / Relief Valve
13,14,15	Relief valve setting*	140	140 bar
		150	150 bar
		160	160 bar
		170	170 bar
		180	180 bar
		190	190 bar
16	Thread Size P	A	3/4-16 UNF (SAE-8) O-Ring Ports
		B	M18x1,5 O-Ring Ports
		C	G 1/2" (BSP) Straight Thread Ports
		D	M22x1,5 O-Ring Ports
17	Thread Size T	A	3/4-16 UNF (SAE-8) O-Ring Ports
		B	M18x1,5 O-Ring Ports
		C	G 1/2" (BSP) Straight Thread Ports
18	Thread Size L, R	A	3/4-16 UNF (SAE-8) O-Ring Ports
		B	M18x1,5 O-Ring Ports
		C	G 1/2" (BSP) Straight Thread Ports
		D	M16x1,5 O-Ring Ports
19	Additional Port Size LS	0	None
		A	7/16-20 UNF (SAE-4) O-Ring Ports
		B	M12x1,5 O-Ring Ports
		C	G 1/4" (BSP) Straight Thread Ports
20	Additional Port Size LS2	0	None
		A	7/16-20 UNF (SAE-4) O-Ring Ports

Position	Feature	Code	Description
21	Additional Port Size LS3	B	M12x1,5 O-Ring Ports
		C	G 1/4" (BSP) Straight Thread Ports
		0	None
		A	7/16-20 UNF (SAE-4) O-Ring Ports
22	Additional Port Size Px	B	M12x1,5 O-Ring Ports
		C	G 1/4" (BSP) Straight Thread Ports
		A	7/16-20 UNF (SAE-4) O-Ring Ports
		B	M12x1,5 O-Ring Ports
23	Coil / Connector Type	C	G 1/4" (BSP) Straight Thread Ports
		A	12 V DC, Deutsch
		B	24 V DC, Deutsch
		C	12 V DC, DIN 43650/ISO 4400
24	Special Features	D	24 V DC, DIN 43650/ISO 4400
		A	None
25	Paint Type	1	Black paint

*It is possible to request different valve setting values than mentioned in the table

Chapter 4

Installation

SbXC with conventional steering unit



SbXC Remote version

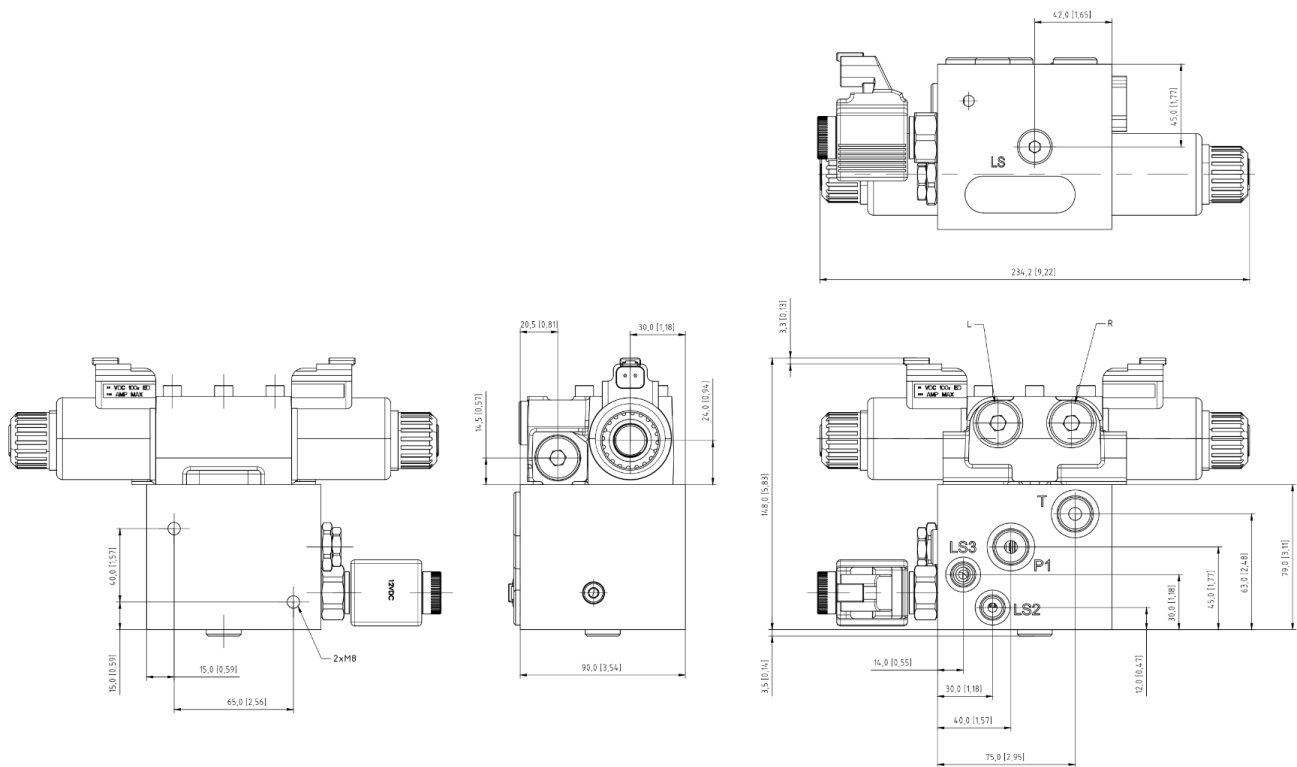


Figure 11: Installation drawing SbXC Remote version

Revision history

Date	Edition	Modification
01/2026	01	Creation

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