



# STEERING

## Technical Information

*SBX advanced 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.



## Contents:

<b>Key definitions and acronyms</b>	<b>4</b>
<b>Chapter 1</b>	<b>5</b>
<b>Introduction</b>	<b>5</b>
Product overview	6
Features	6
Benefits	6
Typical applications	7
<b>Chapter 2</b>	<b>8</b>
<b>Product overview</b>	<b>8</b>
Product introduction	9
Application options	9
<b>Chapter 3</b>	<b>15</b>
<b>SBX Valve Details</b>	<b>15</b>
Technical data and specifications	17
Model code specifications	19
<b>Chapter 4</b>	<b>21</b>
<b>Installation</b>	<b>21</b>
Installation	22
Hydraulic installation details	25
Electrical installation details	26
Revision history	27

## Key definitions and acronyms

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<b>CRV</b>	Cylinder relief valve
<b>LSRV</b>	Load sense relief valve
<b>ECU</b>	Electronic control unit
<b>EH</b>	Electrohydraulic
<b>SBW</b>	Steer by wire
<b>I/O module</b>	Input output module
<b>Isolation Valve</b>	Valve that blocks steering flow from reaching the steer cylinders
<b>Load reaction valve</b>	Valve that dictates if the SCU will behave as a load reaction or non-reaction SCU (for definition on reaction types, see the White steering catalog)
<b>Main spool</b>	Proportional spool that controls gain, through notch design, of both meter-in and meter-out of steering flow
<b>Mode select valve</b>	Valve that directs pressure to open or close the isolation valve as well as the load reaction switching valve
<b>SCU</b>	Steering control unit (e.g. Series 10)

# *Chapter 1*

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## **Introduction**

## Product overview

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The SBX is WHITE's premier CAN controlled electrohydraulic steering valve that can be paired with one of WHITE conventional steering control units to provide advanced EH steering or can be coupled with a manifold valve assembly to provide steer-by-wire functionality. The SBX valve provides mobile off-highway equipment OEMs with a functionally safe and flexible means to implement electronically controlled hydraulic steering on their machines. The inclusion of CAN communication and an onboard spool position sensor yields high precision flow control and opens the door for additional diagnostics and fault management strategies to be incorporated at the vehicle level. Be it EH steering or pure SBW, the SBX valve is an initial step towards safe autonomous steering on mobile off-highway equipment.

## Features

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### User interface:

- J1939 CAN controlled
- Precise steering flow control with near zero hysteresis

### Multiple configurations:

- EH steering with bolt-on SCU (Fail operational)
- EH steering with remote mount SCU (Fail operational)
- Steer-by-wire with backup valve (Fail operational)
- Steer-by-wire standalone (Fail safe)

### Size/range:

- Two flow ratings (30/60 LPM/min)
- Flexible power supply (12 or 24 V)

## Benefits

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### Allows remote mounting

- Reduced cab noise levels
- Reduced hose length

### Enables different steering input devices

- GPS
- Joystick
- Multiple steering wheels

### Enables configurable performance parameters

- Lock-to-lock turns
- Variable steer ratio

## Provides safety

- Suitable for applications up to PLd in accordance with ISO 13849-1

## Standards and certifications

- ISO 13849-1

## Typical applications

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- Material handling
  - Dock side equipment, cranes, telehandlers, forklifts
- Construction
  - Wheel loaders, pavers, etc.
- Agriculture
  - Tractors, harvesters, sprayers

# *Chapter 2*

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## **Product overview**

## Product introduction

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The SBX is a two-stage proportional valve. The main valve is a closed-center, load sense valve which is designed to supply proportional flow to the steering application with high accuracy and ~zero hysteresis. An isolation spool is used, which “isolates” the main-stage spool from the work ports. It is normally closed and piloted (to open) by an on/ off solenoid valve. During normal operation, the isolation valve must remain actuated in order to ensure flow can be delivered to and from the work ports. By removing power to the “mode select valve” the isolation valve can be closed at any time allowing for the isolation of the main-stage spool from the steering cylinder(s).

The SBX will communicate with any CAN-enabled controller. The standard interface with the vehicle controller is CAN J1939. The inclusion of CAN bus communication and an onboard spool position sensor yields high precision flow control. Additional diagnostics and fault management strategies need to be incorporated at the vehicle level.

## Application options

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The SBX is designed to control steering function in machines from the following areas of application:

- Construction machinery
- Agriculture and forest machinery
- Material handling equipment, including cranes and lifting platforms

The manufacturer must be consulted should the SBX be used in an application other than the above mentioned.

The SBX steering valve is designed to be bolted to a secondary hydraulic component, which would interface with SCU-style ports (“P,” “T,” “R,” “L,” and “LS”). The following sections describe three viable architectures for incorporating an attachment to the SBX.

Table 1: Three common SBX configurations

	<b>EH steering (Fail operational)</b>	<b>Steer-by-wire (Fail operational)</b>	<b>Steer-by-wire (Fail safe)</b>
<b>Primary</b>	<b>SBX main valve</b>	<b>SBX main valve</b>	<b>SBX main valve</b>
<b>Secondary</b>	<b>Steering control unit</b>	<b>Backup valve</b>	

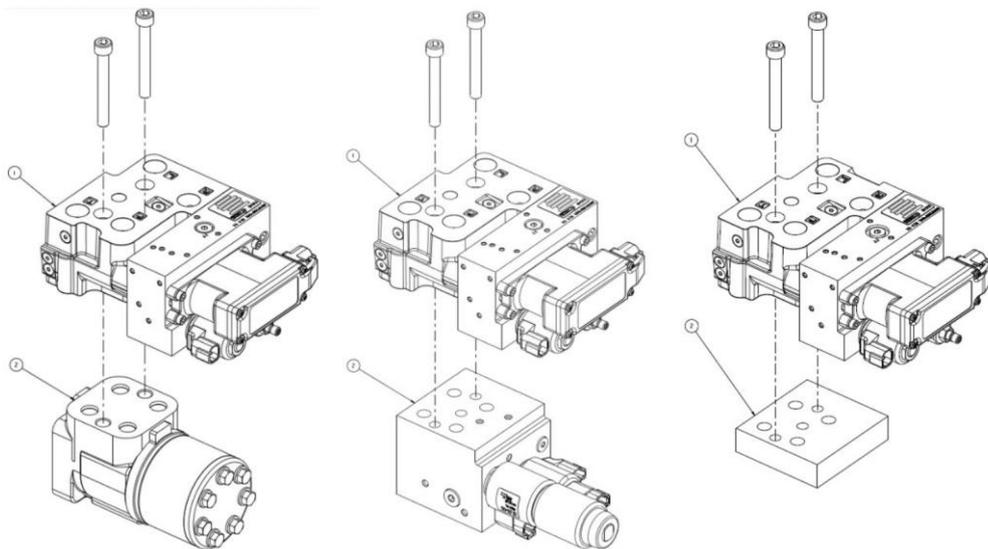


Figure 1: Three common SBX configurations

## Steer-by-wire (SbW) - Fail safe

A fail-safe steer-by-wire steering system uses the SBX valve without any additional steering device.

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 fail-safe steer-by-wire system is appropriate.

This type of architecture would allow for the steering system to be isolated when a safety function is activated by way of the integrated isolation valve.

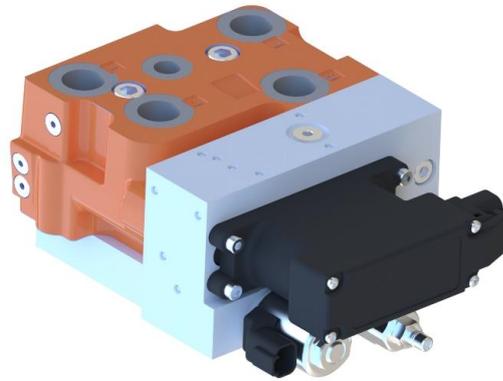


Figure 2.1: SBX SbW (fail-safe) steering control unit

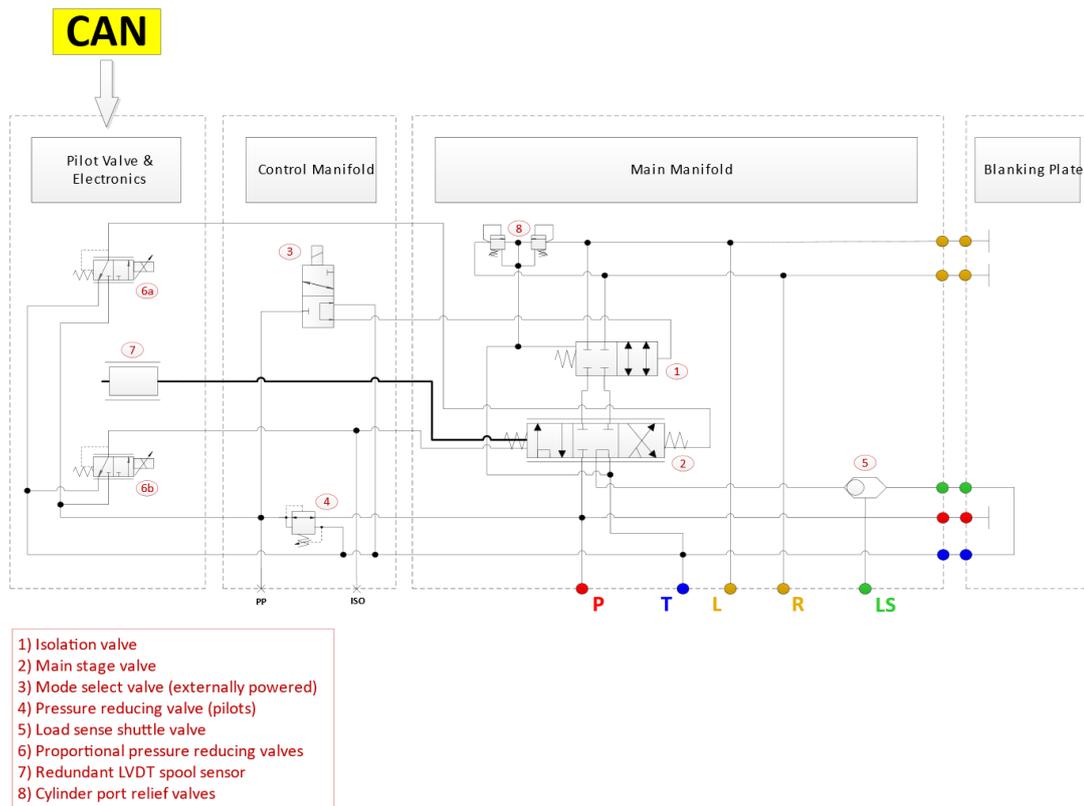


Figure 2.2: SBX SbW (fail-safe) hydraulic circuit

## Fail-operational Electrohydraulic (EH) Steering

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

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

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 SBX safety function activation, the steering control unit remains functional.

In an EH steering system, the SBX 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).

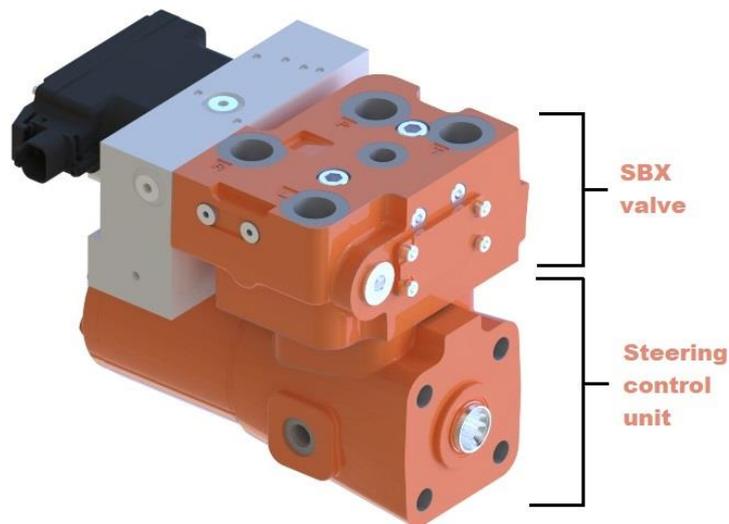


Figure 3.1: SBX EH (fail-operational) steering control unit

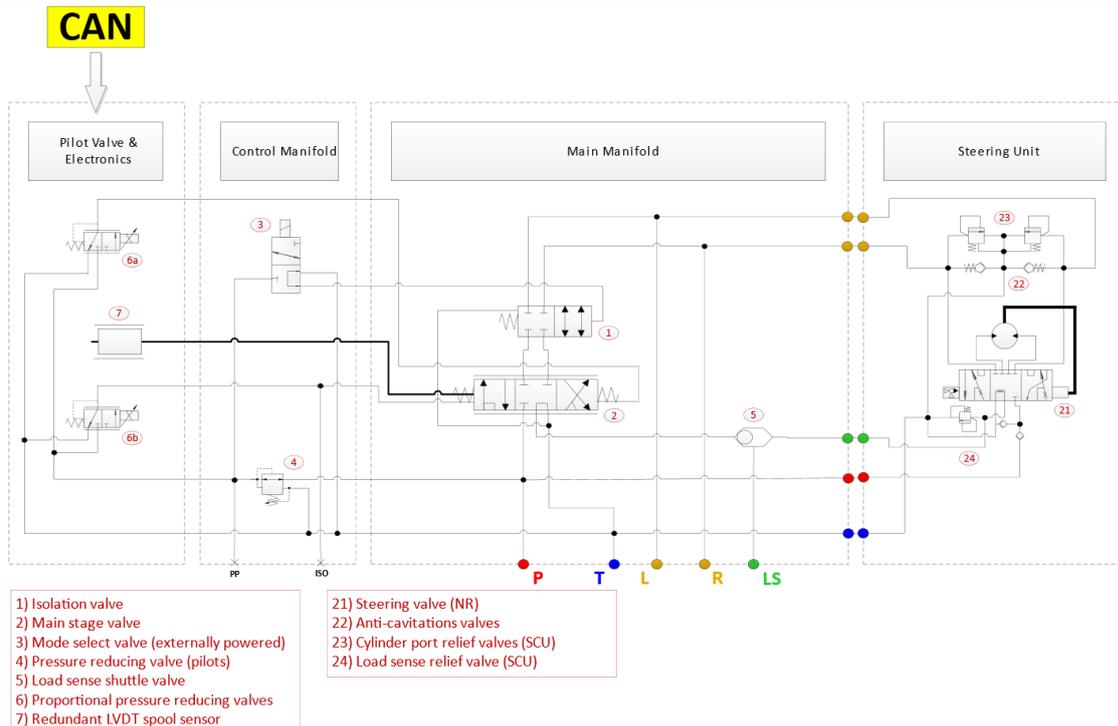


Figure 3.2: SBX EH (fail-operational) hydraulic circuit

## Fail-operational steer-by-wire (SbW)

A fail-operational steering system uses the SBX in parallel with a backup steering manifold. In this type of architecture, the SBX valve can be mounted directly on top of the backup manifold or remotely mounted and coupled with hydraulic hoses.

Advantages of this architecture are:

- Flexible mounting location
- Reduction of in-cab noise
- Flexible input device sensors: steering wheel, joystick, mini-steering wheel
- Enables autonomous operation

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

This type of architecture would allow for the SBX steering valve to be isolated when a safety function is activated by way of the integrated isolation valve. The steering system controller would then automatically switch to commanding the backup steer-by-wire valve. An example of this is shown below in figure 6.



Figure 4.1: SBX SbW (fail-operational) steering unit

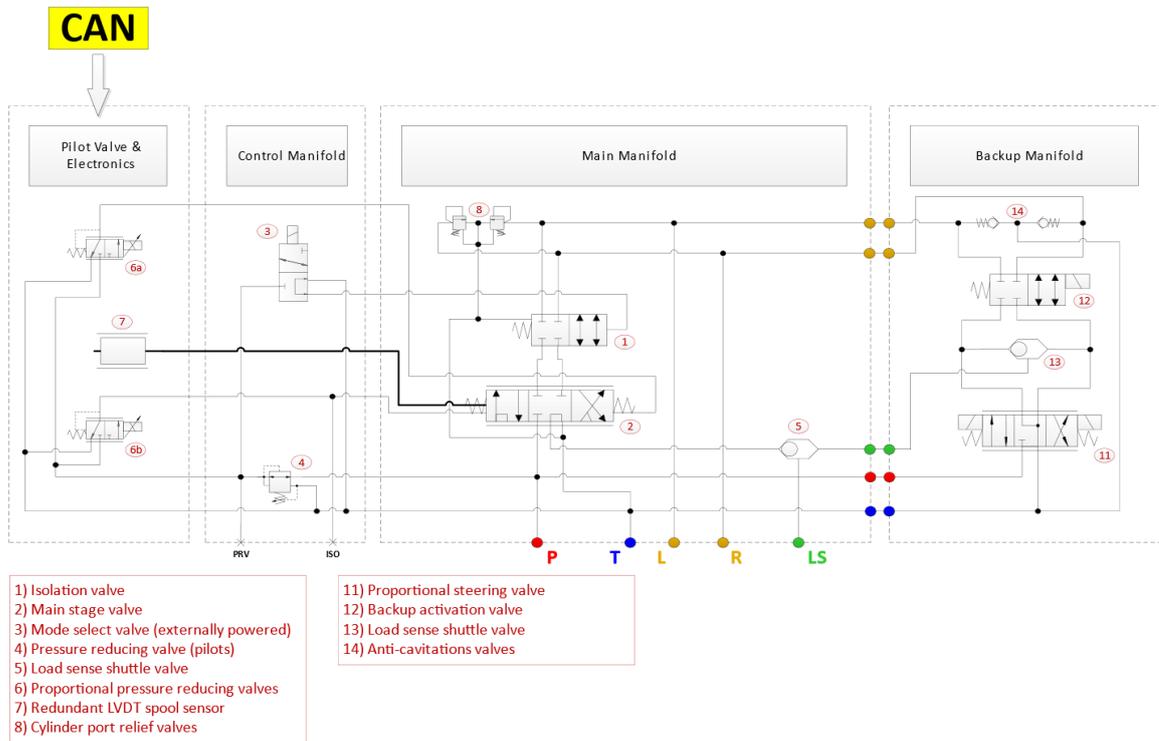


Figure 4.2: SBX SbW (fail-operational) hydraulic circuit

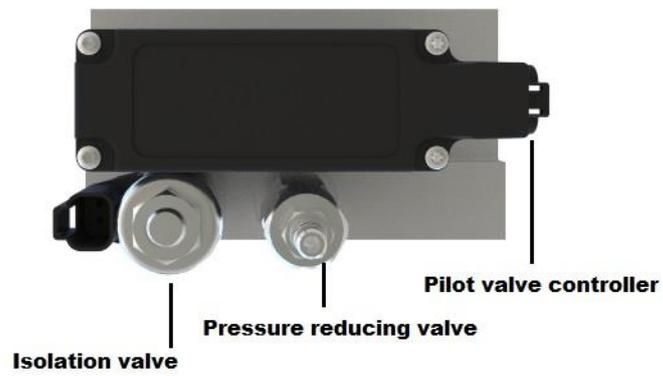
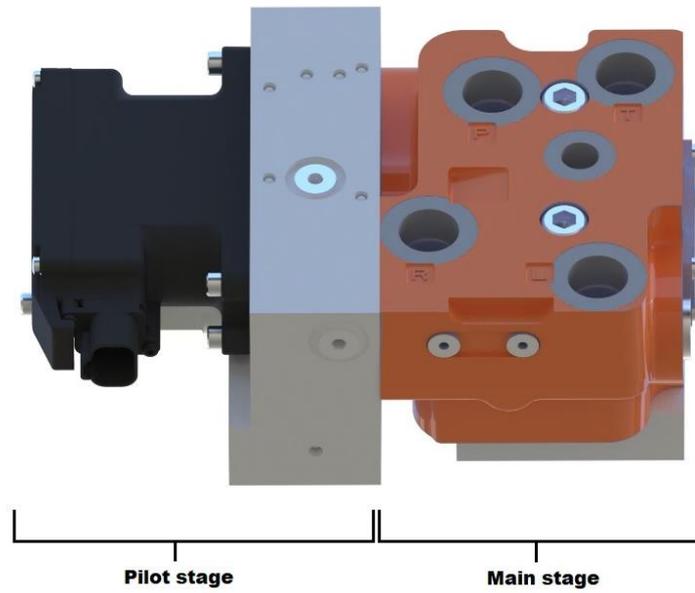
# *Chapter 3*

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## **SBX Valve Details**

## SBX Valve Details

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## Technical data and specifications

<b>Pressures</b>	
Rated inlet port P	210 bar (3045 psi)
Max work ports L, R	250 bar (3625 psi)
Max tank port T	21 bar (305 psi)

<b>Flow at 14 bar control pressure</b>	
SBX low flow	30 L/min (7.9 gal/min)
SBX high flow	60 L/min (15.9 gal/min)

<b>Port type</b>	
P, T, R, L	3/4"-16 UNF (SAE-08) G1/2 M18
LS	7/16"-20 UNF (SAE-04) G ¼ M12

<b>Temperature*</b>	
Standard oil (operating)*	-30 to 90°C (14 to 194°F)
Ambient (operating)	-30 to 95°C (-22 to 203°F)
Ambient short term (operating)	-30 to 105°C (-22 to 221°F)
* It is recommended that the SBX valve not be subjected to a thermal difference of greater than 50°F (28°C)	

<b>Viscosity</b>	
Recommended	12-85 cSt
Minimum	7 cSt
Maximum	812 cSt

<b>Filtration</b>	
ISO 4406	18/16/13
Pilot valve filter screen	125µm

<b>Actuation command options</b>	
Pilot valve flow command	CAN
Isolation valve command	PWM

<b>Control modes</b>	
Closed loop command	+/- 100 % flow

<b>Electrical</b>	
Input voltage	12VDC (9-16 VDC) 24VDC (18-32 VDC)
Power/Current consumption	Pilot Valve – 25 W Max Mode select valve Solenoid – 15.8 W Max
CAN Interface	J1939, 2.0B

<b>Electrical interface connectors</b>	
Pilot valve connector	Deutsch connector: DT14-6P
Solenoid valve connector	Deutsch connector: DT04-2P

<b>Weight</b>	
Standard version (SBX only)	8 kg (17.6 lb)

## Model code specifications

### Model code of an SBX:

Position	1 - 3	4,5	6	7	8	9	10-11	12-14	15-17	18	19-20	21	22-23	24	25	26-27	28-29	30
Code	SBX	60	D	B	1	A	01	000	25 0	C	AG	B	AA	1	0	1D	00	A

Position	Feature	Code	Description
1,2,3	Product	SBX	Version SBX
4,5	Nominal flow rating	30	30 l/min
		60	60 l/min
6	Mounting configuration	C	EH – S 10 bolt on
		D	EH – S 10 dual displacement bolt on
		E	EH – remote mount LS
		F	SBW – Backup-Valve bolt on
		G	SBW – standalone
		H	EH – remote mount LS, R, L
7	Control Input	B	CAN J1939
8	Inlet pressure rating	1	210 bar
9	Neutral circuit	A	Load Sensing, Dynamic Signal
10,11	Valve Options	00	none
		01	Cylinder Relief Valves
		02	Cylinder Relief Valves, Load Reaction Valve
		03	Load Reaction Valve
		04	Load Sense Relief Valve
		05	Cylinder Relief Valves, Load Sense Relief Valve
		06	Cylinder Relief Valves, Load Sense Relief Valve, Load Reaction Valve
		07	Load Reaction Valve, Load Sense Relief Valve
12,13,14	Load Sense Relief Setting*	000	none
		140	140 bar
		150	150 bar
		160	160 bar
		170	170 bar
		180	180 bar
		190	190 bar
		200	200 bar
		210	210 bar
15,16,17	Cylinder Relief Valve Setting*	000	none
		140	140 bar
		150	150 bar

Position	Feature	Code	Description
		160	160 bar
		170	170 bar
		180	180 bar
		190	190 bar
		200	200 bar
		210	210 bar
		220	220 bar
		230	230 bar
		240	240 bar
		250	250 bar
18	Thread Size P, T, 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
19,20	Additional Port Size LS	AC	7/16-20 UNF (SAE-4) O-Ring Ports
		AE	M12x1,5 O-Ring Ports
		AG	G 1/4" (BSP) Straight Thread Ports
21	Coil / Connector Type	A	12 V DC, Deutsch
		B	24 V DC, Deutsch
22,23	Special Features	AA	none
24	Paint Type	1	Black paint
25	Identification	0	Product Number
26,27	Firmware	1C	Version 35
		1D	Version 36
28,29	Software configuration	00	Standard
30	Design Code	A	001

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

## Model code position 7 - SBX control type/input

B: Closed loop / CAN J1939

The SBX valve is ready to communicate on a J1939 network as shipped from the factory. The J1939 version of the valve operates at 250 kb as specified by J1939.

# *Chapter 4*

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## **Installation**

# Installation

## SBX standard (remote mount)

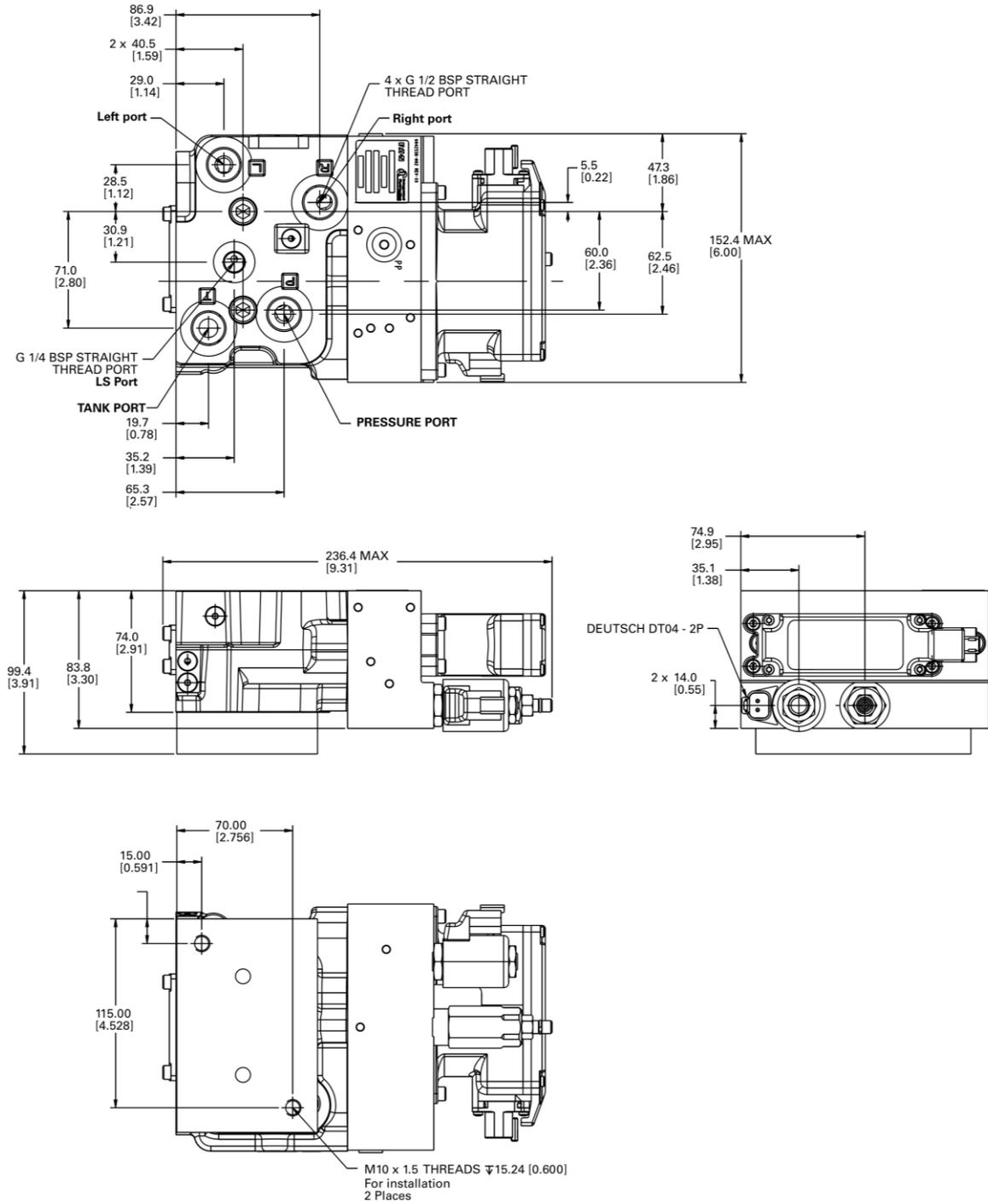


Figure 6: Installation drawing – SBX standard

SBX with backup manifold:

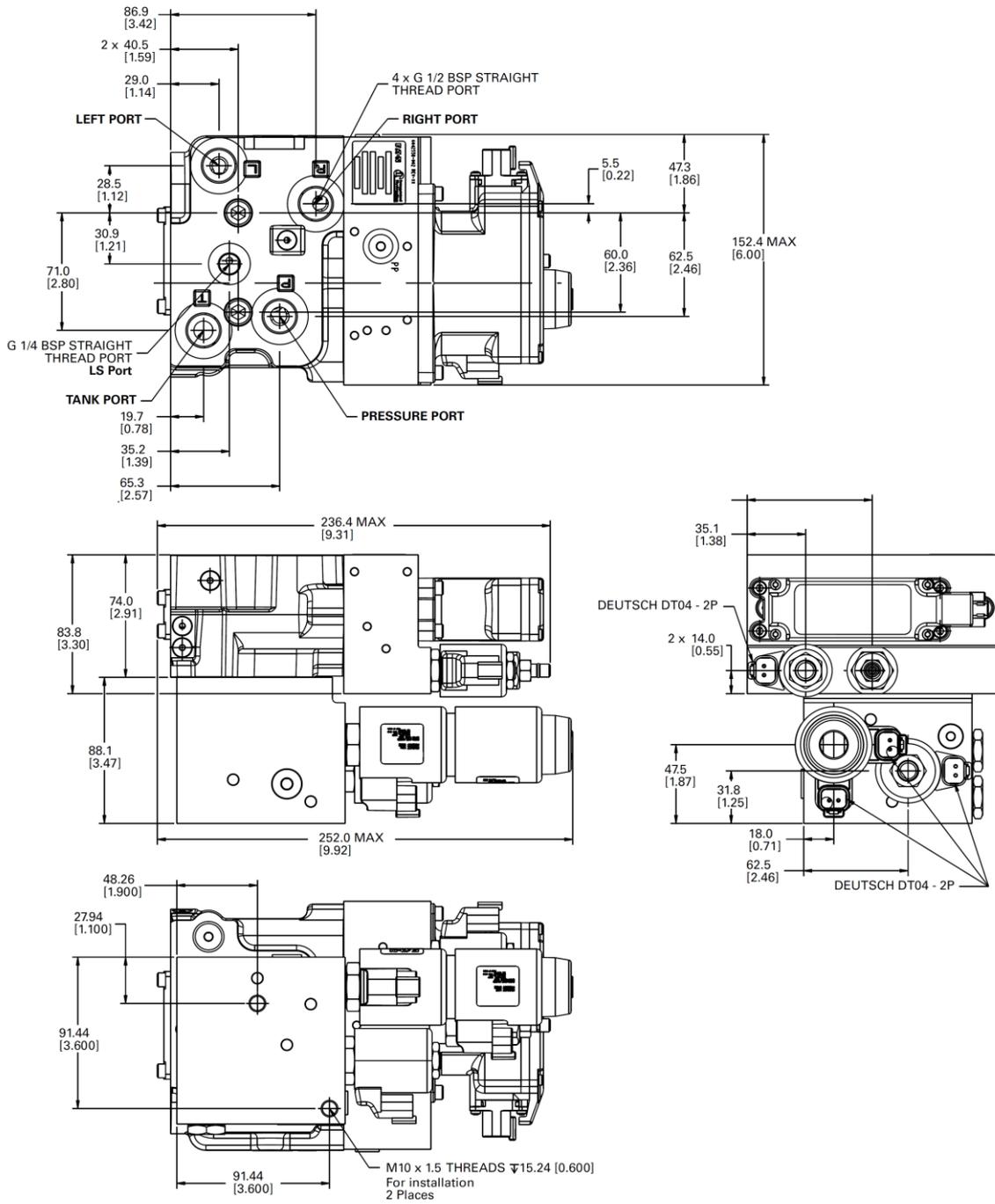


Figure 7: Installation drawing - SBX with backup manifold

### SBX Electrohydraulic with conventional CSU

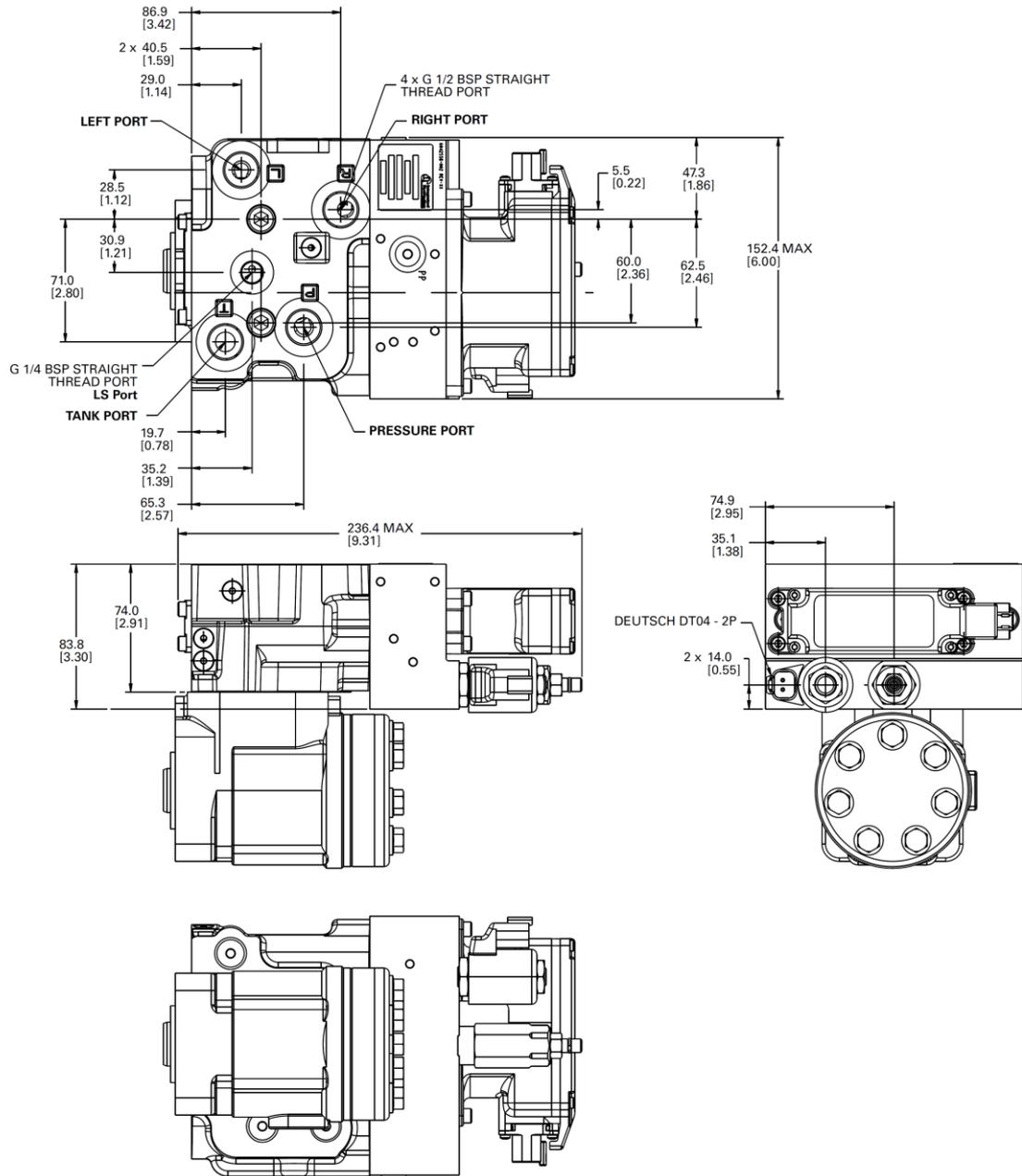


Figure 8: Installation drawing - SBX with SCU

\*For installation dimensions of SCU refer to White's Series 10 or LAGC catalog

## Hydraulic installation details

The SBX has five hydraulic connections: Inlet (P port), work ports (L & R ports), tank (T port), and load sense

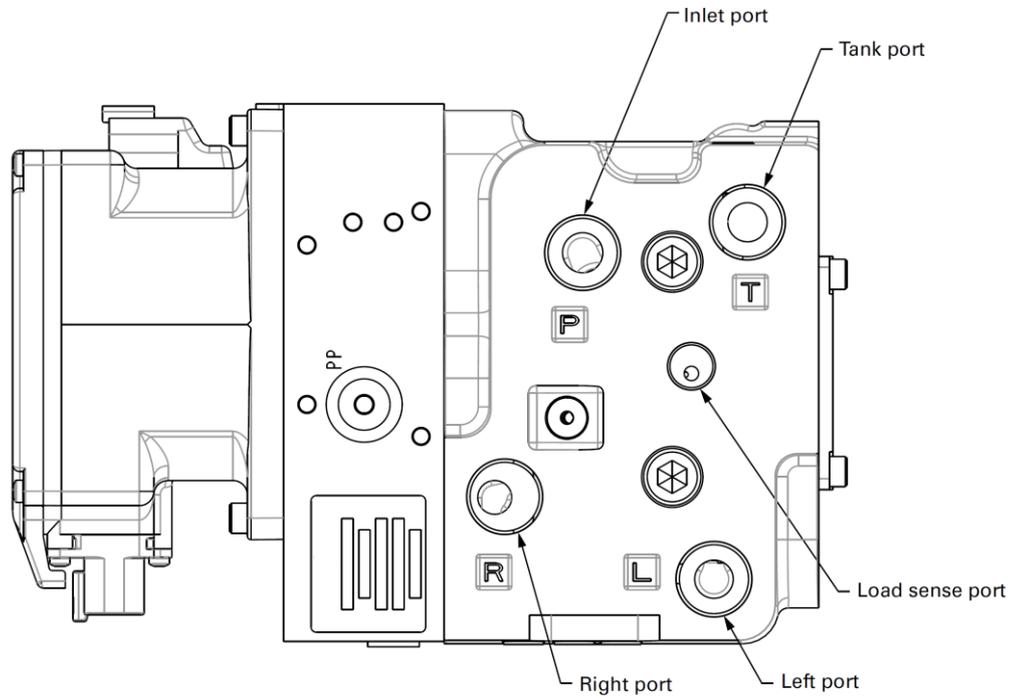


Figure 9: SBX hydraulic ports

### SBX steering system hydraulic circuit recommendations

1. The SBX is designed to be used in a steering system with a load sense pump.
2. The SBX valve is designed to be used with a control pressure of 14 bar (200 psi).
3. Use a load sense or inlet relief valve to protect the steering system from over pressurization.
4. Protect the steering cylinders from anti-cavitation (can be included in SCU or backup manifold).
5. Protect the steering cylinders from over-pressurization (included as an option on SBX).
6. Use a dedicated tank return hose from the SBX to prevent negative pressure.

## Electrical installation details

### SBX connector details

Pilot valve connector:

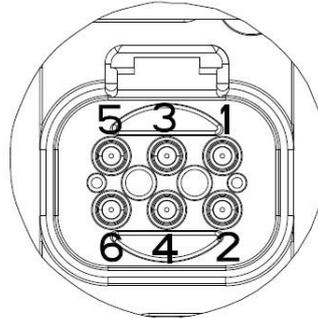


Figure 10: Connector Deutsch DT14-6P

Pilot valve Deutsch connector DT14-6P

1. Power source (+)
2. CAN low
3. None
4. None
5. Power source (-)
6. CAN high

To build the complete mating connector for the pilot valve, the following parts are needed:

Housing: DT16-6SA-KP01 (grey)  
DT16-6SB-KP01 (black)

Socket pin contacts: Deutsch part no: 0462-201-16141

**SBX mode select valve, backup isolation valve and backup proportional valve solenoid connector:**

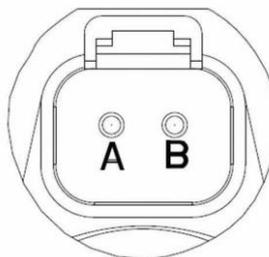


Figure 11: Connector Deutsch DT04-2P

Side A: Polarity (+ positive)

Side B: Polarity (- negative)

Mating connector: Deutsch DT06-2S

## Revision history

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Date	Edition	Modification
02/2023	01	Creation

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