RE 01939
Edition: 2024-05

rexroth
A Bosch Company

Software module for position/force control of a hydraulic drive

H4U.app xF

- PLC function block for position/force control of a hydraulic drive
- Control of valves and pump systems for valve-controlled and displacement-controlled drive concepts
- For Siemens and Beckhoff control systems
- Various actuator topologies

Features

- Position control
- Velocity control
- Direct operation
- Active damping (state controller)
- Force control
- Alternating control (e.g. position/force)
- For directional control valves type 4WRPEH, 4WRLE, 4WRTE, and WRCE
- For internal gear pumps type PGH and PGF
- For axial piston pumps type A4VSO, A4VBO, A10VZO, A10VSO and A10FZO
- Component database included

Contents

Ordering code

▶ Software

01	02	03	04	05	06	07	08
SWA-HYD	**–** **T**	**–** **XF****	**–**	**–** **01**	**–** **RS**	**–** **NN**	**–** **N**

01	Software for hydraulic applications	**SWA-HYD**
02	Technology library	**T**

Category

03	Position / force control	**XF****

Target system

04	Siemens TIA Portal	**TIA***
	Beckhoff TwinCAT 3	**TC3***
05	Version 01	**01**
06	Release RS	**RS**
07	Patch	**NN**

Export indicator

08	Standard	**N**

Target system	PLC runtime system	Recommended control hardware [1)]
Siemens	TIA Portal (as of version 15)	SIMATIC S7-1500
Beckhoff	TwinCAT 3	Embedded PC series CX5100, CX8100

[1)] The PLC runtime system is a prerequisite for the use of the software. Selection of suitable control hardware depends on the specific application and is determined by the user.

▶ Software license

01	02	03	04	05	06	07
SWL-HYD	**–** **T**	**–** **XF****	**–** **BASIC*M01***	**–** **01**	**–** **P01**	**–**

01	Software license for hydraulic applications	**SWL-HYD**
02	Technology library	**T**

Category

03	Position / force control	**XF****

Scope of functions

04	Base, number of regulated axes: 1	**BASIC*M01***

Version

05	01	**01**
06	Permanent license, 1 license activation	**P01**

Target system

07	Siemens TIA Portal	**TIA***
	Beckhoff TwinCAT 3	**TC3***

Function

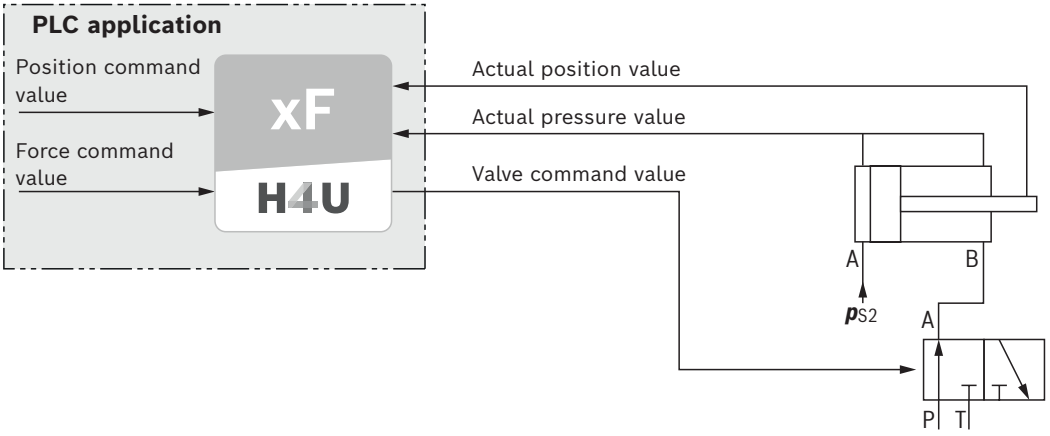
The software module "H4U.app xF" regulates the position (x) or the force (F) of a hydrostatic drive.
It supports various actuator topologies for valve-controlled and displacement-controlled drives and can be integrated directly into the PLC application of the existing machine control system.
For the supported actuator topologies, the software module already realizes a good following behavior in controlled operation through the implemented actuator adjustment.
In the control of valves, control takes the valve characteristic curves and the current system pressures (cylinder, tank, supply) into account.

In the control of pumps, the software calculates the limit values for control using the performance data of the pump. Operating state monitoring ensures that the pump is operated within the admissible operating limits.

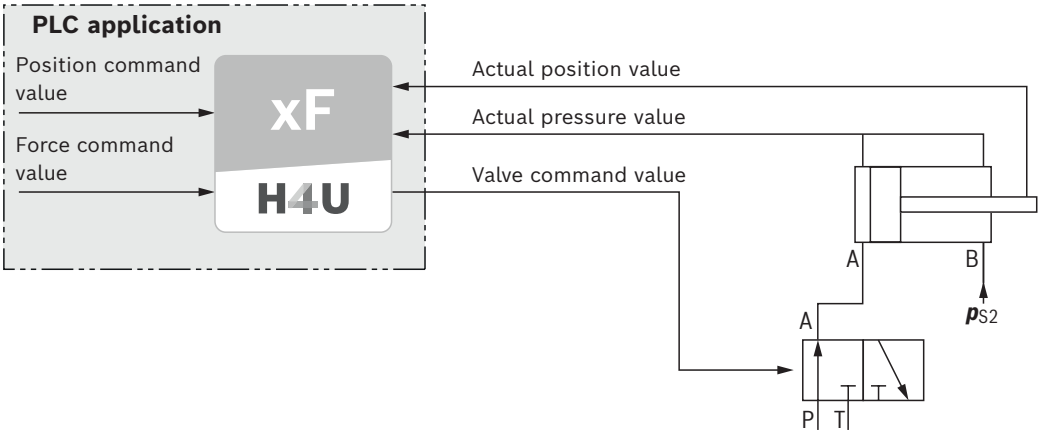
Basic possible applications for position/force control (x/F) in valve-controlled drive concepts

In a valve-controlled drive, the position (x) or force (F) of the hydrostatic drive is regulated via the flow that flows over the control edges of the valve.
With this concept, several actuators can be operated simultaneously with one pump when it supplies several proportional directional control valves.

Actuator topology "3/2-directional control valve"
With the cylinder preloaded on the piston side, the load can be retracted and extended by pushing and pulling.
The cylinder is preloaded with the system pressure p_{S2} on the piston side.

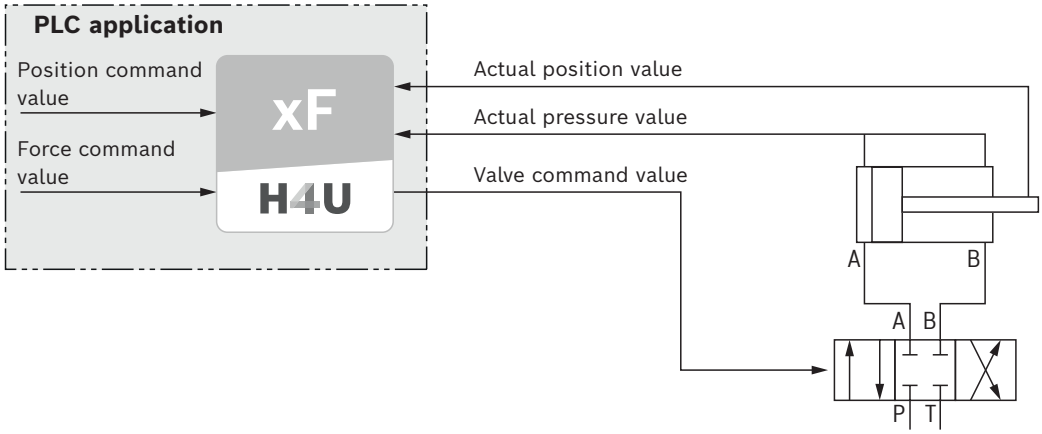


With the cylinder preloaded on the ring side, the load can be retracted and extended by pushing and pulling.
The cylinder is preloaded with the system pressure p_{S2} on the ring side.

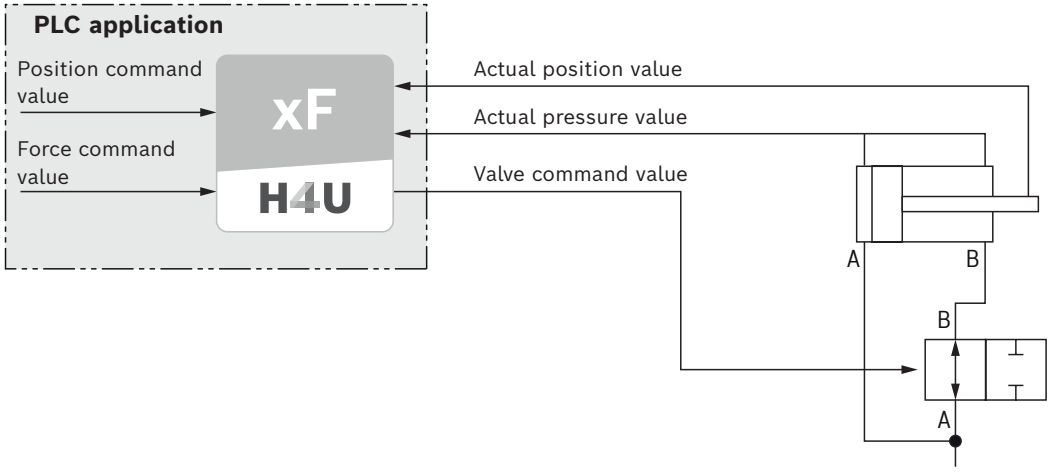


Basic possible applications for position/force control (x/F) in valve-controlled drive concepts

Actuator topology "4/3-directional control valve"
The load can be retracted and extended by pushing and pulling. Positioning with no load is also supported.

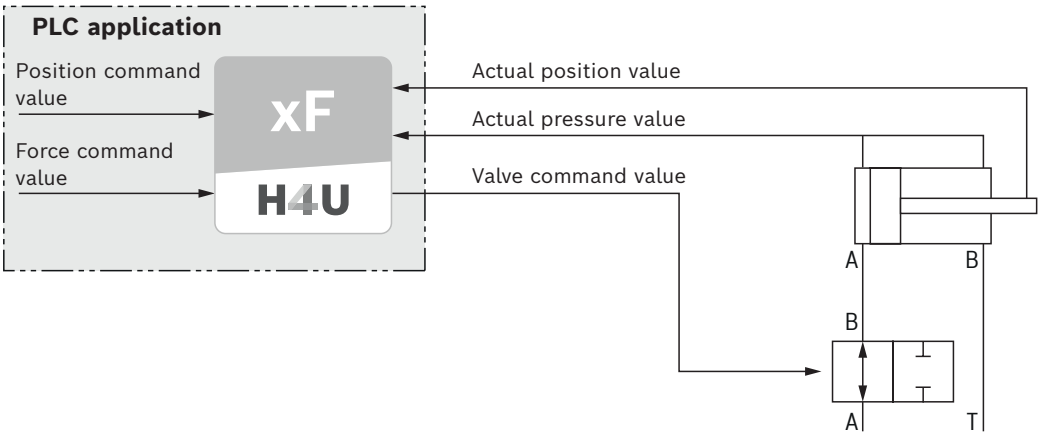


Actuator topology "differential circuit"
With 2/2-directional high-response valves in a differential circuit, the piston can be extended by pushing or pulling. The hydraulic fluid displaced on the ring side remains in the hydraulic circuit.

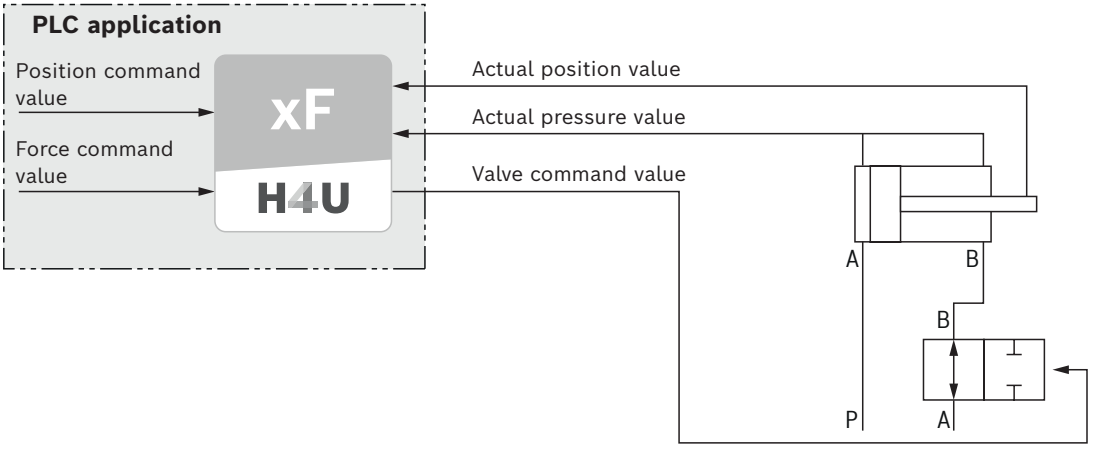


Basic possible applications for position/force control (x/F) in valve-controlled drive concepts

Actuator topology "meter in"
The piston can only be extended by pushing.



Actuator topology "meter out"
The piston can only be extended by pushing.

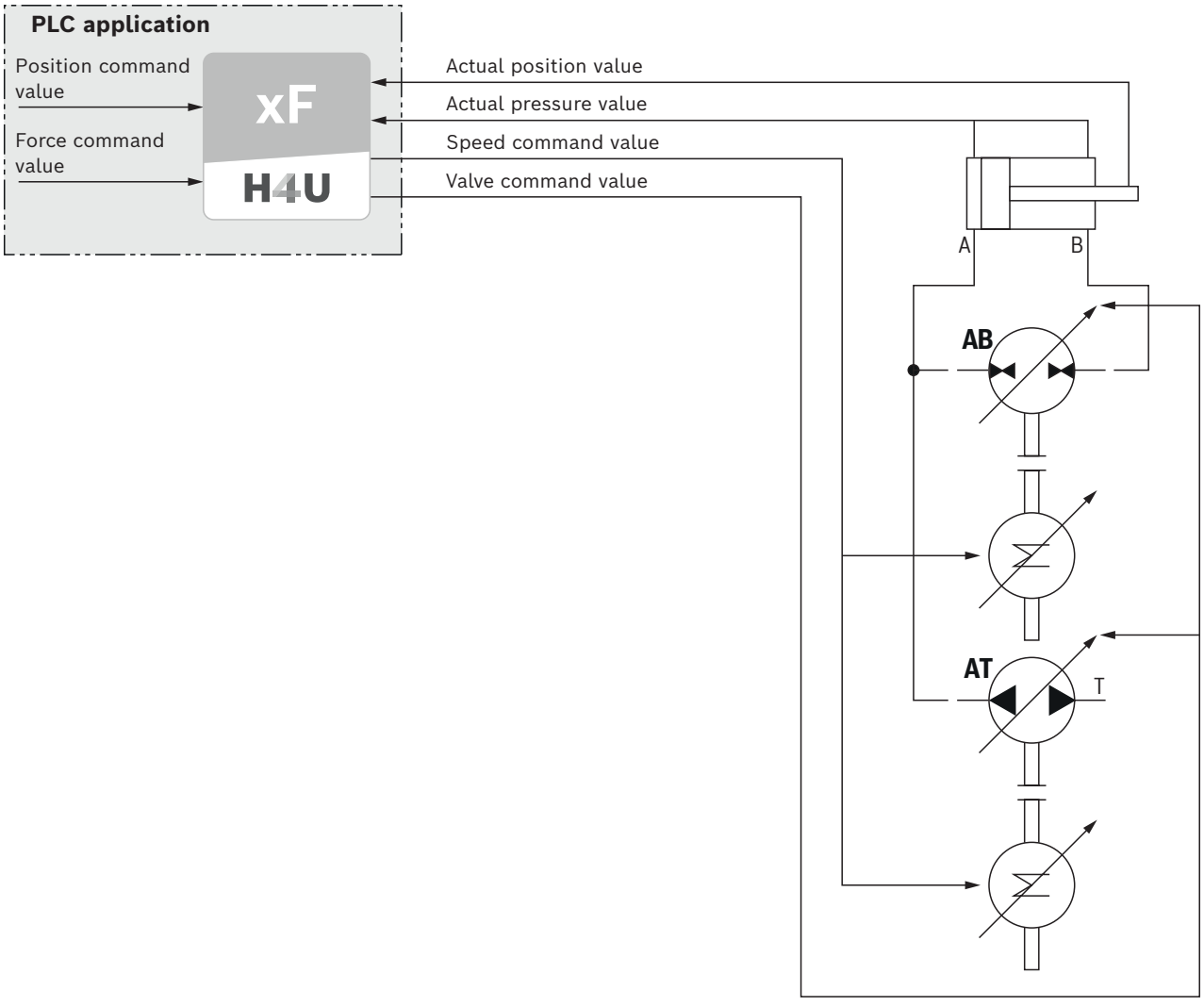


Basic possible applications for position/force control (x/F) in displacement-controlled drive concepts

With a displacement-controlled drive, the position or force of the hydrostatic drive is controlled via the flows delivered by the pumps.
With this concept, only one actuator can be operated with one pump at a time. Several actuators can be moved sequentially if they are connected via on/off valves.

Actuator topology "adding transformer"
The load can be retracted and extended by pushing and pulling. For this purpose, one pump is used in four-quadrant and one in two-quadrant operation.

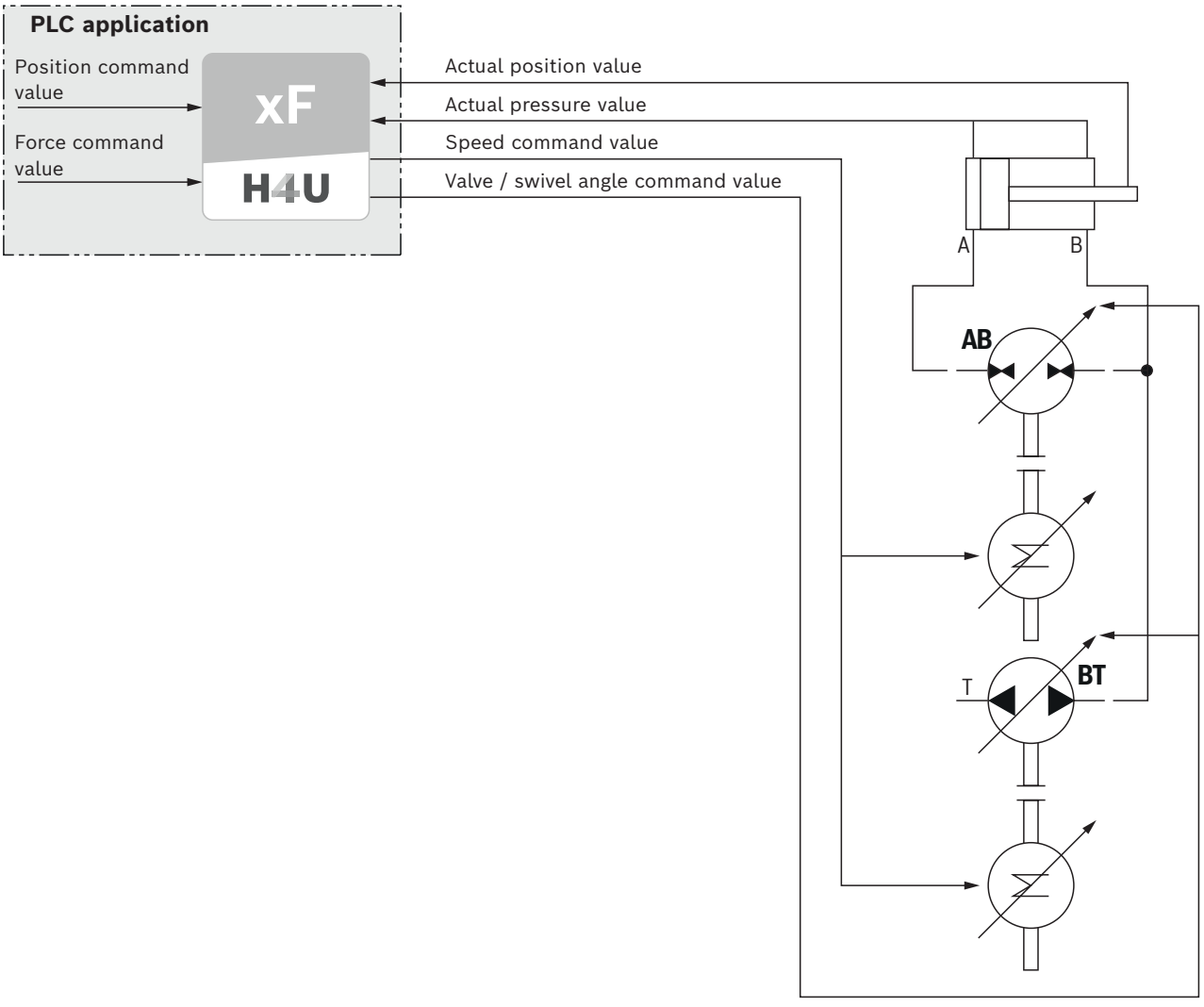
The ring volume of the cylinder is conveyed via the pump "AB". The pump "AT" conveys the rod volume. Depending on the application, the pumps can be operated both at the same speed (mounted on the same shaft) and at different speeds.



Basic possible applications for position/force control (x/F) in displacement-controlled drive concepts

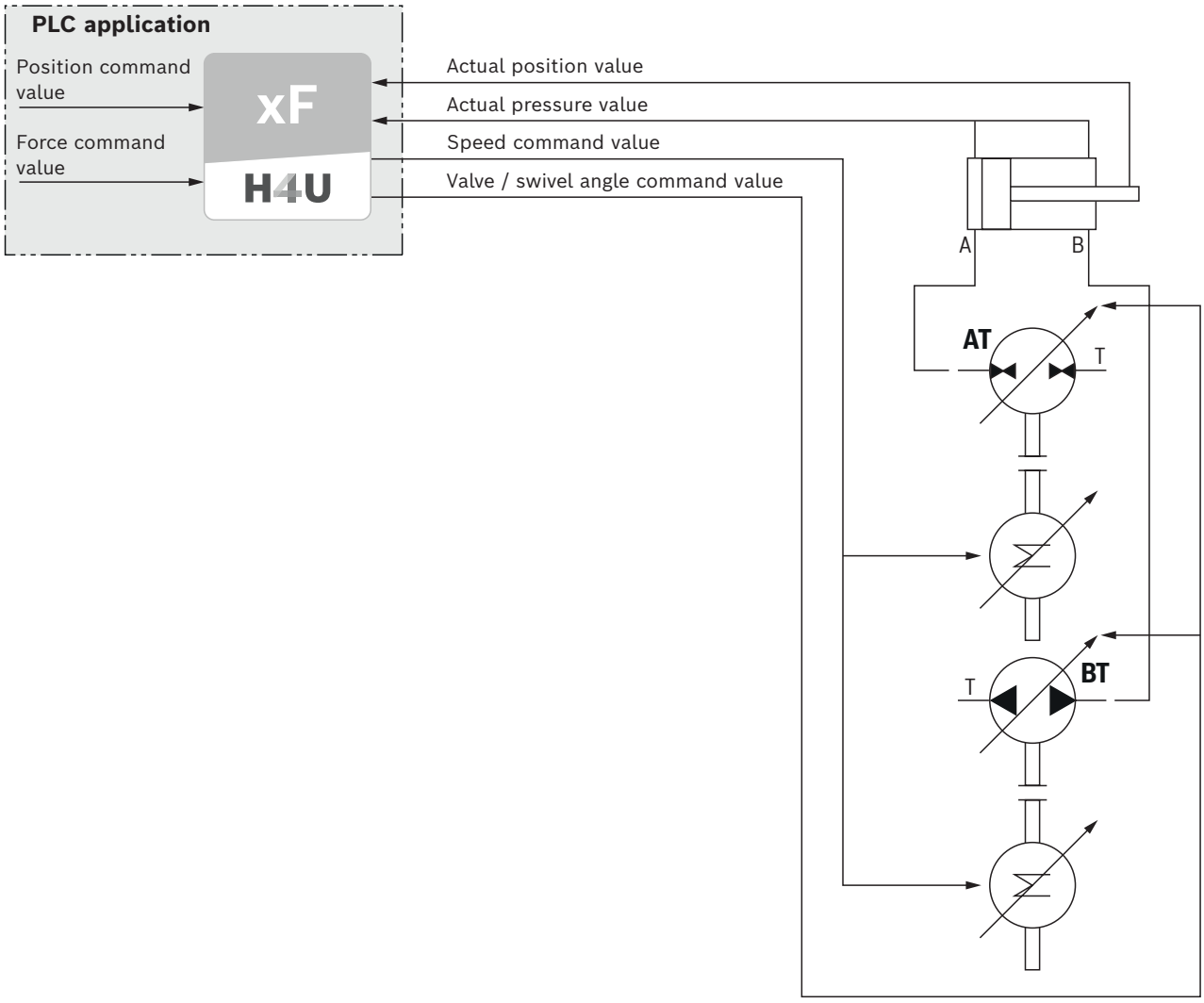
Actuator topology "subtracting transformer"
The load can be retracted and extended by pushing and pulling. For this purpose, one pump is used in four-quadrant and one in two-quadrant operation.

The piston volume of the cylinder is conveyed via the pump "AB". The pump "BT" provides the rod volume. Depending on the application, the pumps can be operated both at the same speed (mounted on the same shaft) and at different speeds.



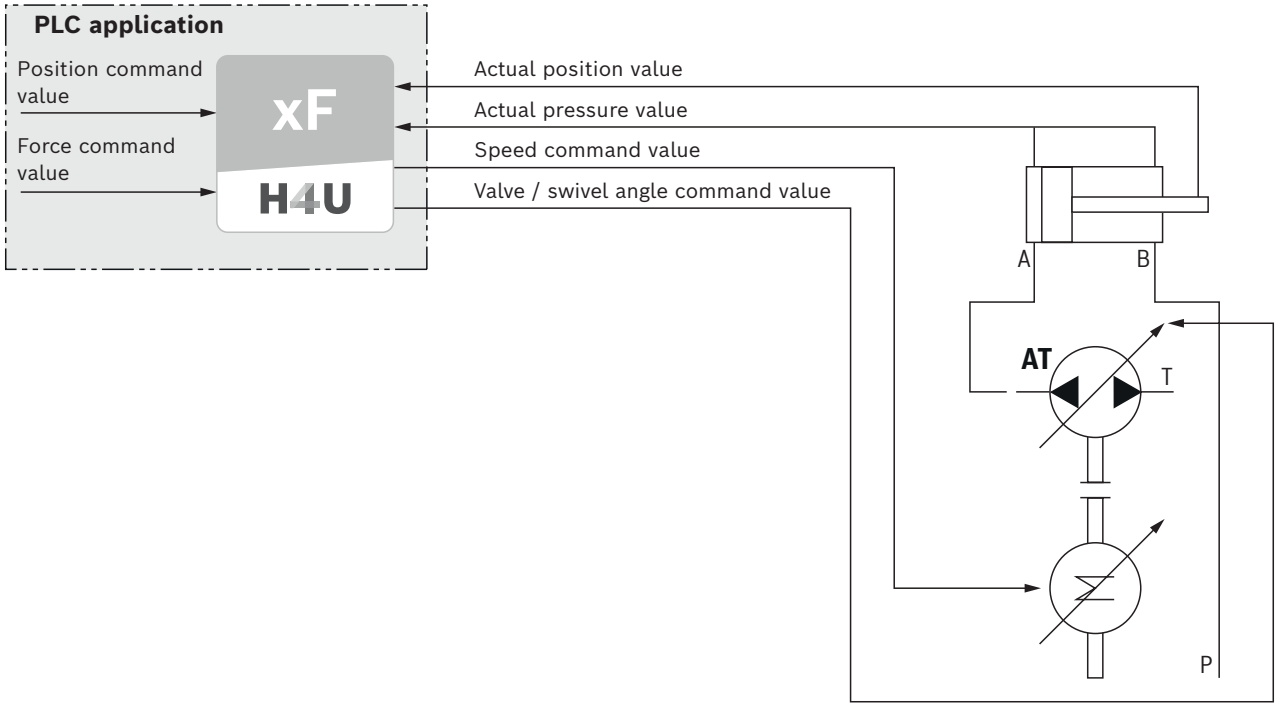
Basic possible applications for position/force control (x/F) in displacement-controlled drive concepts

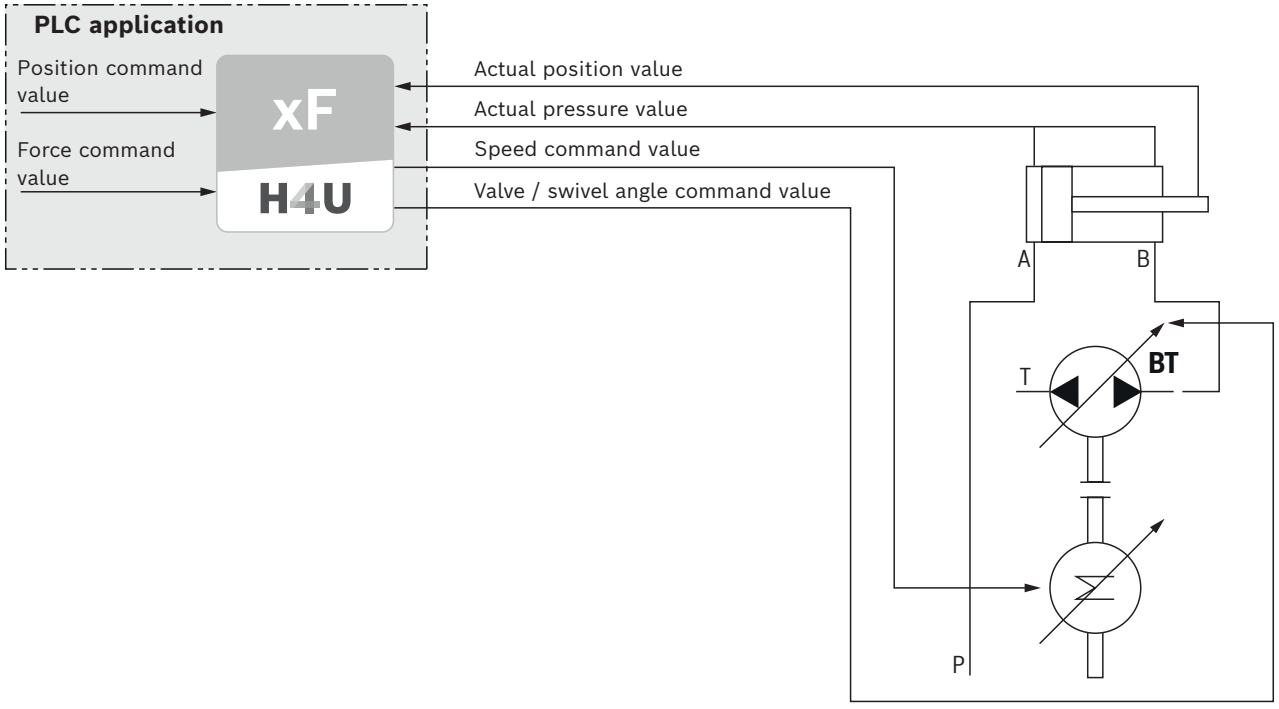
Actuator topology "serial transformer"
The load can be retracted and extended by pushing and pulling.
For this purpose, two pumps are used in two-quadrant operation.



Basic possible applications for position/force control (x/F) in displacement-controlled drive concepts

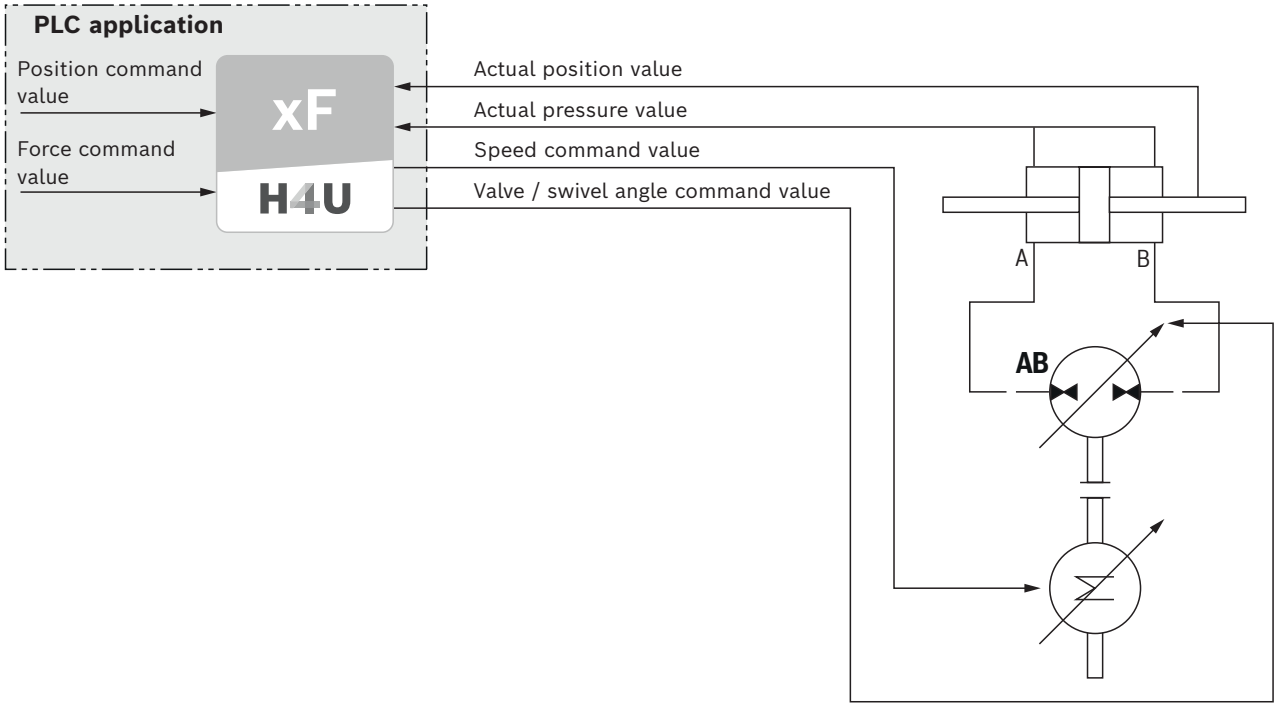
Actuator topology "single-sided preloaded cylinder"
The load can be retracted and extended by pushing, if preloaded on the ring side, or by pulling, if preloaded on the piston side.





Basic possible applications for position/force control (x/F) in displacement-controlled drive concepts

Actuator topology "double-acting cylinder"
The load can be retracted and extended by pushing and pulling.



Technical data

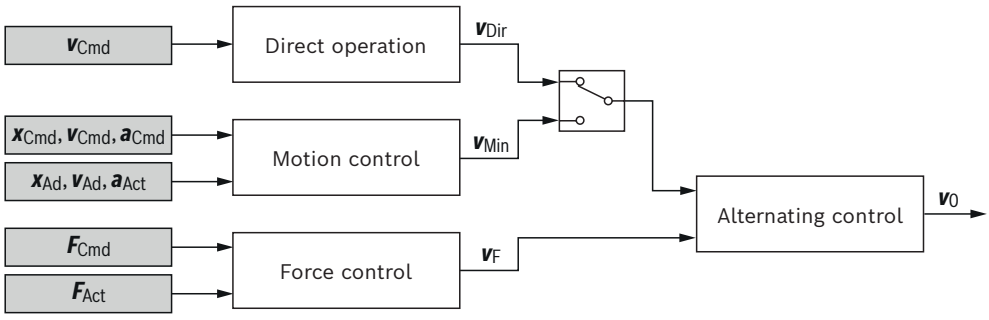
xF control		
Position control		✓
Velocity control		✓
Force control		✓
Active damping (state controller)		✓
Alternating control (e.g. position/force)		✓
Actuator adjustment		✓
Direct operation		✓
Supported actuator topologies		
Valve-controlled drive	▶ 4/3-directional high-response valve (e.g. full bridge)	✓
	▶ 4/2-directional high-response valve (e.g. center tapped coil)	✓
	▶ 2/2-directional high-response valve (e.g. recuperation circuit)	✓
Displacement-controlled drive	▶ Adding transformer	✓
	▶ Subtracting transformer	✓
	▶ Serial transformer	✓
	▶ Single-sided preloaded cylinder	✓
	▶ Double-acting cylinder	✓
Operating status control		
Operating limit determination		✓
Operating state monitoring		
Internal gear pumps		PGH; PGF
Axial piston pumps		A10VZO; A10FZO
Component database		
Valve-controlled drive	▶ 4/3-directional high-response valve	4WRPEH; 4WRLE; 4WRTE
	▶ 2/2-directional high-response valve	WRCE
Displacement-controlled drive	▶ Internal gear pumps	PGH; PGF
	▶ Axial piston pumps	A10VZO; A4VSO; A10FZO; A10VZO; A4VBO

Block diagram (simplified)

Controller function

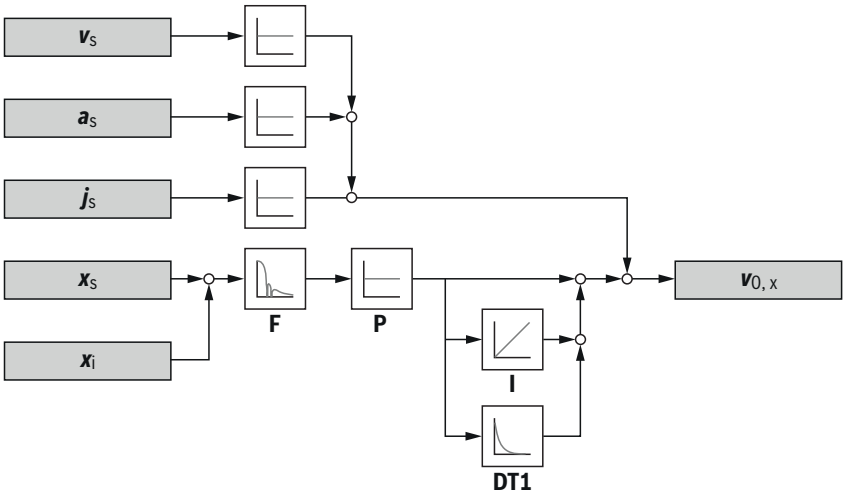
The software module "H4U.app xF" regulates the motion (position, velocity) and force (F) of a hydraulic drive.
It includes motion control, force control, and alternating control for the switch-over between these controllers during operation.
The motion controller includes both a position and a velocity controller. An integrated state controller improves the dynamic behavior of the drive ("active damping").

With alternating control, it is possible to switch between force control and another process variable control (position, velocity) during operation. Both process variable controllers are active, only one having a pass-through to the control distance. The pass-through is controlled by a configurable logic.
Direct operation allows the control value of the motion controller to be specified externally. It may be used in combination with the alternating control.

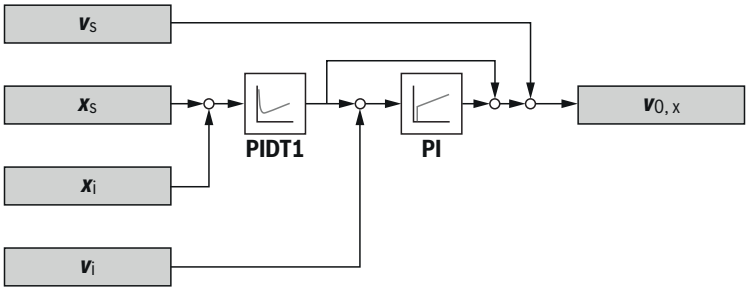


Block diagram (simplified)

Position controller
The position controller is a PIDT1 controller with pilot control. The functions of input signal filtering, filter cascade for the control deviation, an integrator for fine positioning, and velocity pilot control that can be optionally activated can be used to significantly improve the control quality. The fact that the drive follows the command value can be monitored via the lag error or by comparison with a simplified model of the regulated drive.

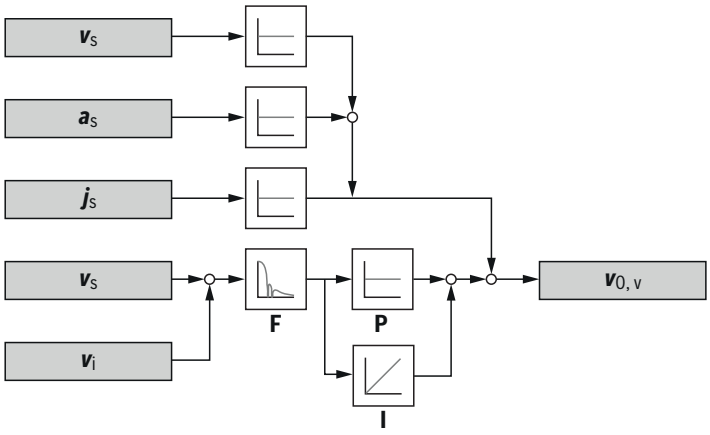


The following behavior can be improved by the optional subordinate velocity controller (PI-).

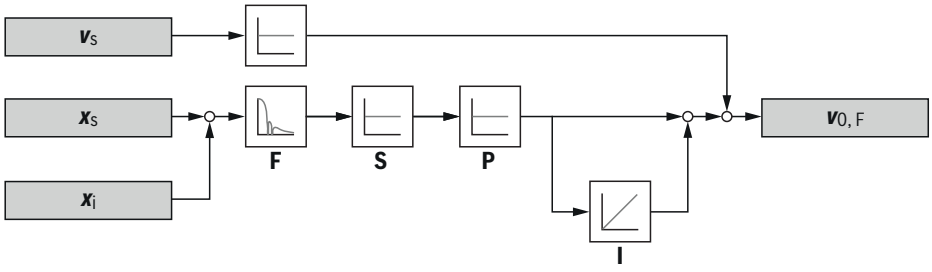


Block diagram (simplified)

Velocity controller
The velocity controller ensures a precise travel velocity of the hydraulic drive on the basis of a PI controller with pilot control.
The control quality can be improved via optional input signal filtering, filter cascade, and pilot control functions.



Force controller
The force controller ensures controlled force application of the hydraulic drive on the basis of a PI controller.
The optional filter cascade and pilot control functions can be used to adjust the control behavior.



Further information

▶ Function block H4U.app Position Force	Functional description 01939-FK
▶ Function block H4U.app Position Force for Beckhoff TwinCAT 3	Quick start guide 01939-01-Z
▶ Function block H4U.app Position Force for Siemens TIA Portal	Quick start guide 01939-02-Z
▶ Internal gear pump, fixed displacement; type PGH	Data sheet 10227
▶ Internal gear pump; type PGF	Data sheet 10213
▶ Axial piston variable displacement pump; type A10VSO	Data sheet 92711, 92714
▶ Axial piston variable displacement pump; type A4VSO	Data sheet 92050
▶ Axial piston variable displacement pump; type A10VZO	Data sheet 91485
▶ Axial piston variable displacement pump; type A4VBO	Data sheet 92122
▶ Axial piston fixed displacement pump; type A10FZO	Data sheet 91485
▶ Directional control valves, direct operated; type 4WRPDH	Data sheet 29391
▶ Directional control valves, pilot-operated; type 4WRLE	Data sheet 29123
▶ Directional control valves, pilot-operated; type 4WRTE	Data sheet 29083
▶ Directional cartridge valves, pilot-operated, type 2WRCE	Data sheet 29406

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