sun hydraulics®

ELECTRO-HYDRAULIC SOLUTIONS

This guide provides several examples of electro-hydraulic (E-H) solutions based on Sun's XMD valve drivers and electro-hydraulic valves. Sample circuits illustrate pump and cylinder control, motor speed control, fan drive control and other pressure and flow control applications. Examples of closed-loop PID pressure control, position control and speed control use Sun's CANpoint XMD Configuration Software for quick set-up and configuration.

The circuits in this document are intended as general technical examples or starting points for new circuit design and should not be relied upon as final designs for specific applications.

E-H Solutions

Market:	Application:	Function:
MOBILE, INDUSTRIAL	**PUMP CONTROL**	**PRESSURE CONTROL**

Hydraulic Displacement Control (HDC): XMD-02 for Directional Axial Piston Pumps
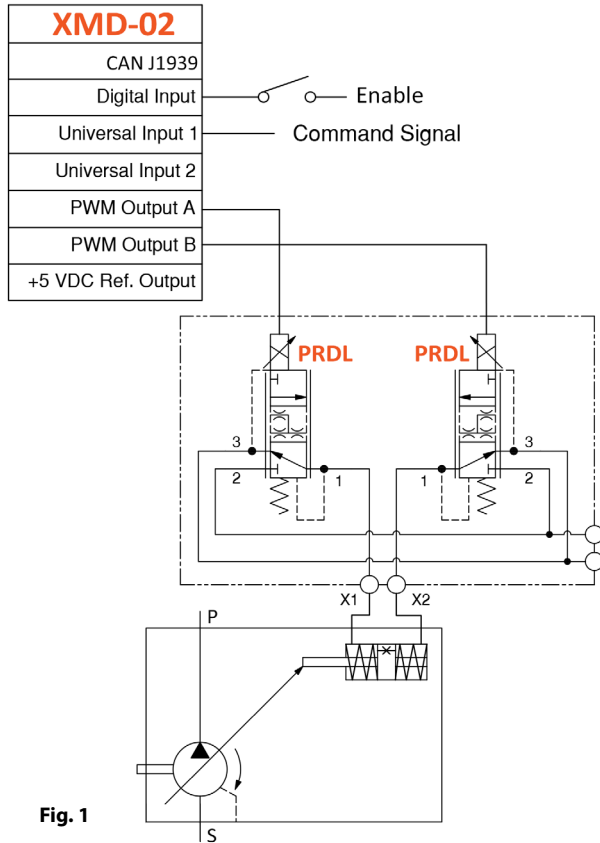

Fig. 1

Fig. 2

This solution combines the XMD-02 with two PRDLs to control the displacement and swashplate angle of an axial piston pump by controlling the two pilot pressure lines (X1 and X2). Using Sun's CANpoint XMD configuration software, the user can quickly and easily configure the XMD to control pumps from several manufacturers.

In **Figure 1,** the XMD is configured to control two electro-proportional valves using a single input to control the displacement and swash plate angle of an axial piston pump.

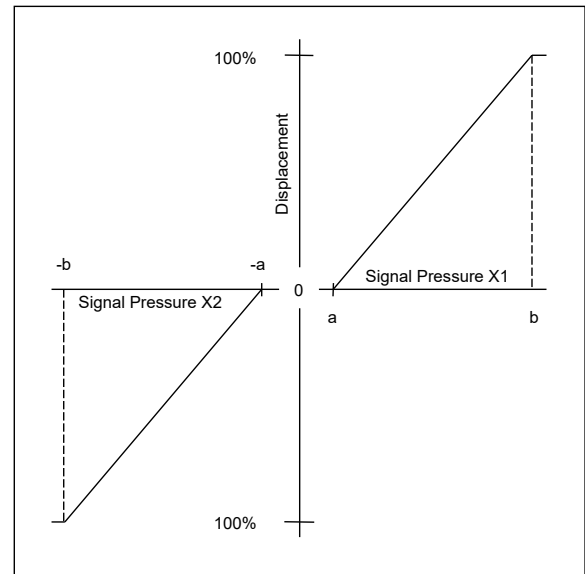**Figure 2** is a simplified diagram that correlates the pump signal pressure to pump displacement and direction.

Related Products

- **XMD-02** dual-output driver
- Two **U8M** line-mount manifolds
- **PRDL-X*N** - Electro-proportional, direct-acting pressure-reducing/relieving valve with open transition
  - **-XSN** 10-100 psi (3,5-33,5 bar)
  - **-XEN** 25-250 psi (1,7-18 bar)
  - **-XDN** 50-485 psi (3,5-33,5 bar)
  - **-XBN** 100-1125 psi (7-77,.5 bar)

Market: **MOBILE, INDUSTRIAL**	Application: **SAW FEED**	Function: **SPEED CONTROL**

Directional Cylinder Control:
XMD-02 for Feed Cylinder Control
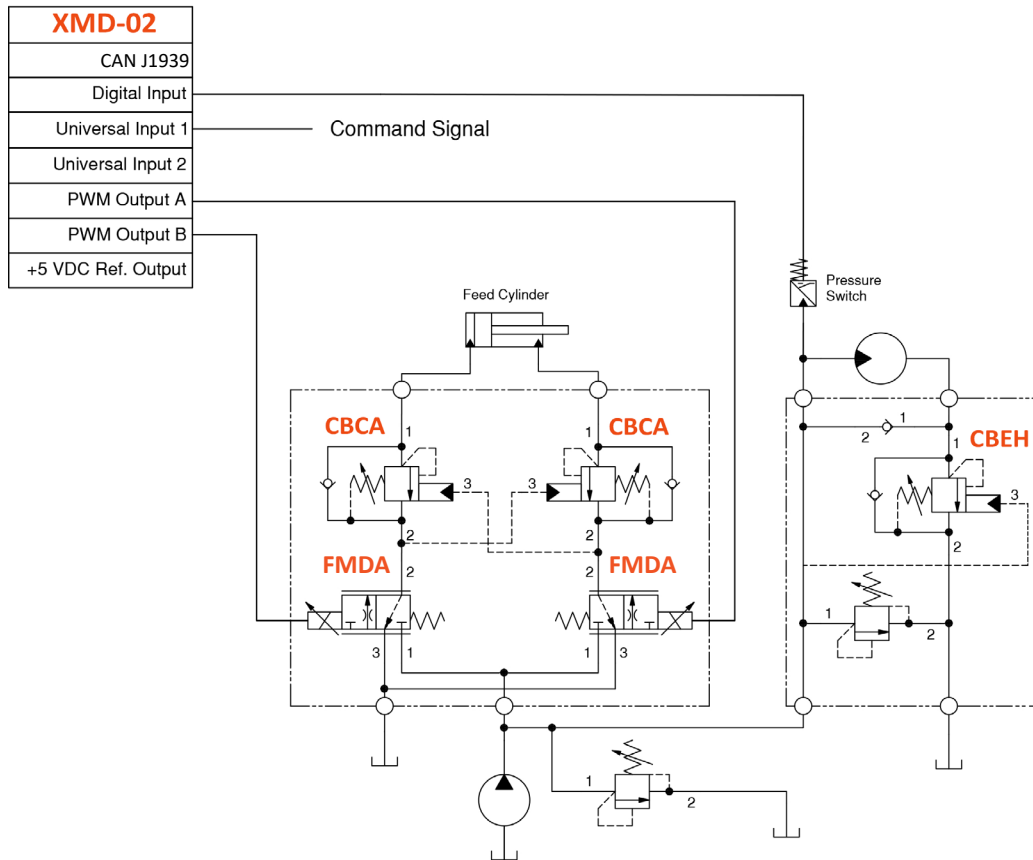
This solution combines the XMD-02 with two FMDA 3-way, meter-in proportional control valves that control the speed of a feed cylinder to a saw motor.

The universal input is used for the command signal. The pressure switch on the digital input (enable) will stop the advance of the feed cylinder if the saw motor is bogged down and creating excessive torque. Using ramps on the outputs will produce smooth acceleration and deceleration of the feed cylinder.

CANpoint can be used to configure the XMD-02 to reduce the opening of the FMDA by reducing the output if the pressure at the motor inlet rises too high.

The two independent PWM outputs can be configured for the FMDA 3/2 proportional control valves. These can be sized for the appropriate flow rate based on the cylinder ratio.

Related Products

- **XMD-02** dual-output driver
- **FMDA-X*N** - Electro-proportional 3-way flow control valve, meter in
    - **-XAN** 0.1-1.6 gpm (0,4-6,1 L/min)
    - **-XBN** 0.1-4 gpm (0,4-14 L/min)
    - **-XCN** 0.1-6 gpm (1-28 L/min)
    - **-XDN** 0.1-9 gpm (1-40 L/min)
- **CBCA-L*N** - 3:1 pilot-ratio counterbalance valve
    - **-LBN / -LIN** 400-1500 psi (28-105 bar)
    - **-LHN / -LAN** 1000-4000 psi (70-280 bar)
- **CBEH-L*N** - 10:1 pilot-ratio counterbalance valve

E-H Solutions

Market:	Application:	Function:
MOBILE, MARINE	**MAIN CONTROL VALVE**	**DIRECTIONAL CONTROL**

Hydraulic-to-Electric Pilot Conversion: XMD-02 for Remote Hydraulic Pilot-Controlled Directional Valves

Fig. 1

Fig. 2
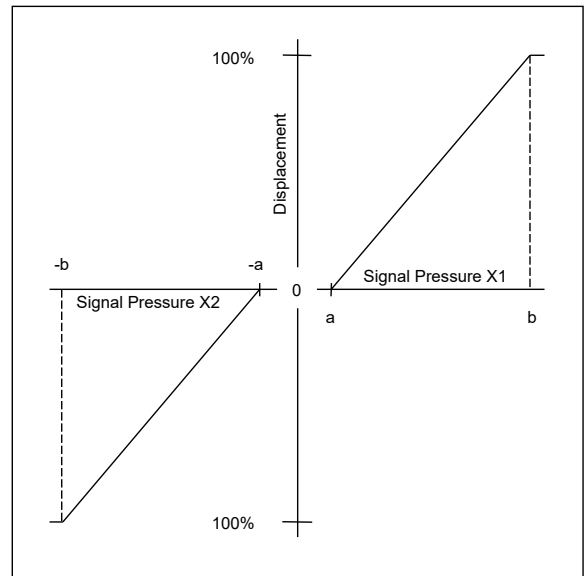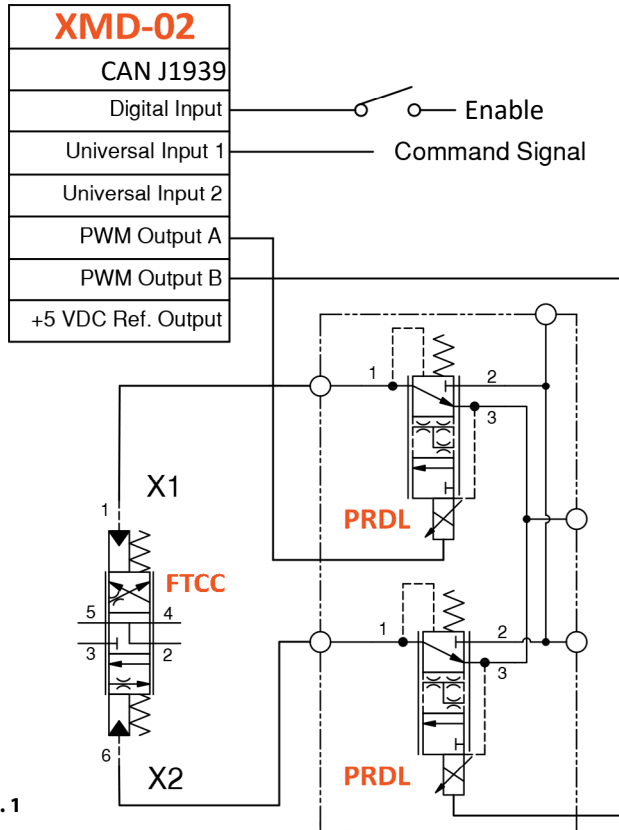
This solution combines the XMD-02 with two PRDLs to control the FTCC meter-in proportional directional valve. The two PRDLs control the two pilot pressure lines (X1 and X2) to control the flow and direction of the directional valve.

CANpoint XMD configuration software can help users configure the XMD to control a wide range of pilot-operated proportional directional valves.

In **Figure 1,** the XMD is configured to control two electro-proportional valves using a single input to control the two signal pressures (X1 and X2).

Figure 2 is a simplified diagram that correlates the output signal pressure to the displacement and direction of the proportional directional valve.

Related Products

- **XMD-02** dual-output driver
- Two **C4I** line-mount manifolds
- **U6F** line-mount manifold
- **FT*C** - 4-way, 3-position, meter-in proportional directional valve
- **PRDL-XDN** - Electro-proportional, direct-acting pressure-reducing/relieving valve with open transition and operating range of 50-485 psi (3,5-33,5 bar)

Market:	Application:	Function:
MOBILE, INDUSTRIAL	**PRESSURE CONTROL**	**PRESSURE CONTROL**

Pressure Control: XMD-01 for Precise Pressure Relief

Fig. 1

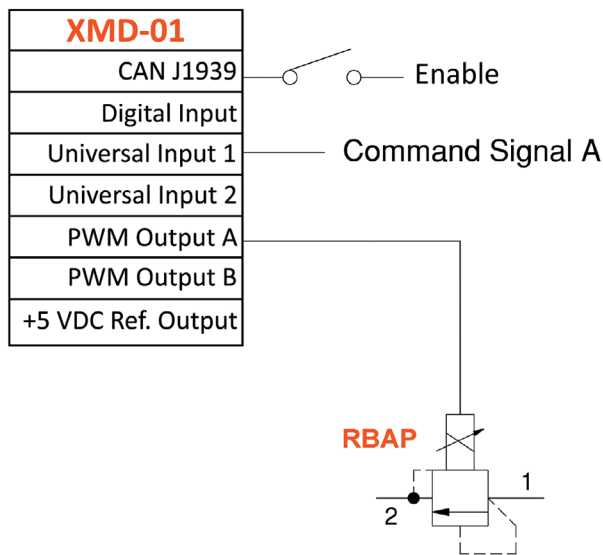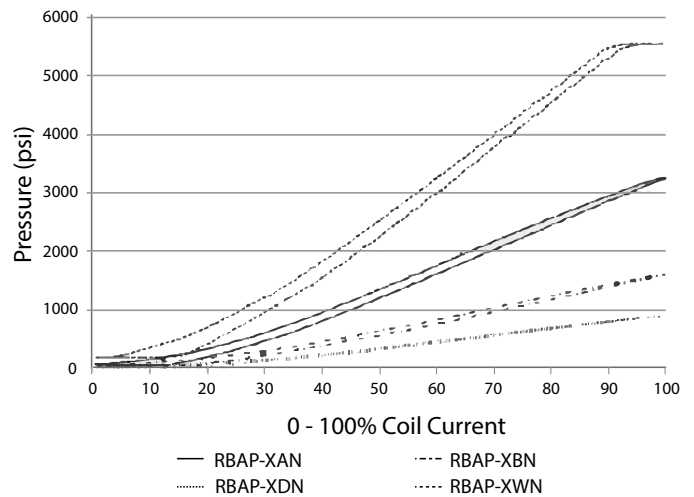**Fig. 2**

This solution utilizes the precision of the RBAP electro-proportional pressure relief valve and the XMD-01 to control system pressure. This solution can control applied force in press applications or to de-stroke pumps.

The XMD-01 offers a single universal input and CAN bus input for maximum configurable options. The user can control pressure directly using a potentiometer or via the primary machine controller.

Using Sun's CANpoint XMD configuration software, the user can configure the XMD to control a wide range of electro-proportional relief valves.
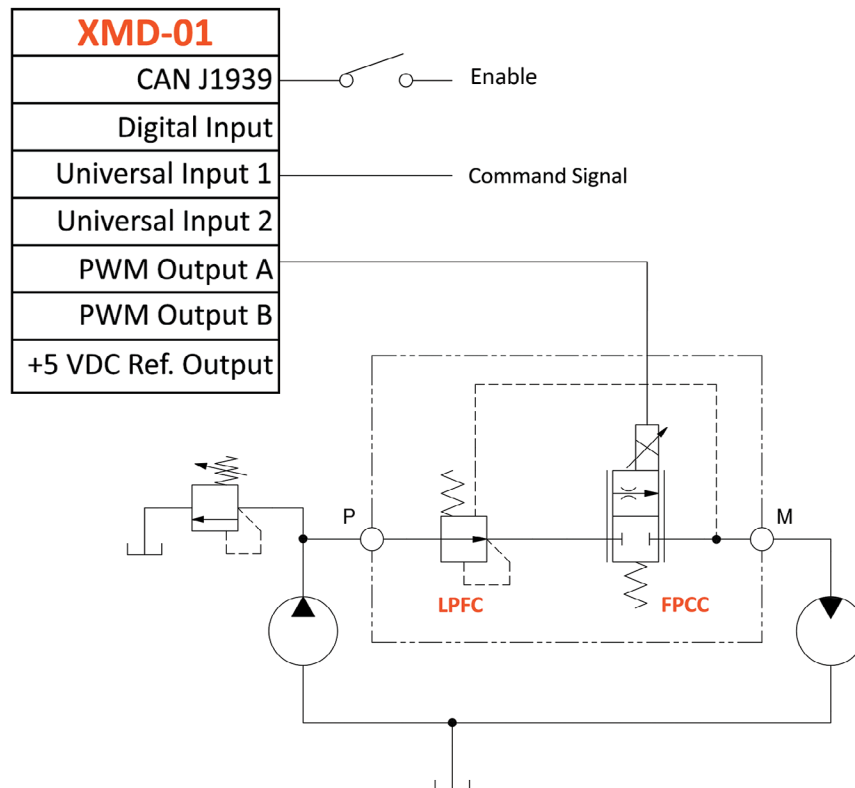
In **Figure 1,** the XMD is configured to control an RBAP electro-proportional relief valve using a single input.

Figure 2 depicts the various RBAP pressure ranges and accuracy.

Related Products

- **XMD-01** single-output driver
- **WFN** line-mount manifold
- **RBAP-X*N** - Electro-proportional relief valve
  - **-XDN** 50-750 psi (3,5-33,5 bar)
  - **-XBN** 150-1500 psi (10,5-105 bar)
  - **-XAN** 300-3000 psi (20-210 bar)
  - **-XWN** 500-5000 psi (35-350 bar)

E-H Solutions

Market: **MOBILE, INDUSTRIAL**	Application: **MOTOR CONTROL**	Function: **MOTION CONTROL**

Pressure-Compensated Flow Control: XMD-01 for Motor Speed Control

This solution uses the XMD-01 to control Sun's FPCC electro-proportional flow control valve for speed control of unidirectional hydraulic motors.

In this circuit, the LPFC modulating element acts as a compensator. The load pressure adds to the setting of the compensator in order to maintain the pressure drop across the flow control valve. In open loop, this helps to maintain flow across the flow control valve for a consistent motor speed under varying loads.

The XMD in this solution is configured to control a single electro-proportional flow control valve using a single input to control the flow through the hydraulic motor.

Using Sun's CANpoint XMD configuration software, the user can easily configure the XMD to control a wide range of electro-proportional flow control valves.

Related Products

- **XMD-01** single-output driver
- **ECJ** line-mount manifold
- **A3K** line-mount manifold
- **FPCC-X*N** - Electro-proportional directional valve
  - **-XAN** 0.1-1.5 gpm (0,4-5,7 L/min)
  - **-XBN** 0.15-3.5 gpm (0,6-14 L/min)
  - **-XCN** 0.25-7 gpm (1-28 L/min)
  - **-XDN** 0.25-10 gpm (1-40 L/min)
- **LPFC-X*N** - Normally open modulating element
  - **-XDN** 50 psi (3.5 bar)
  - **-XFN** 100 psi (7 bar)
  - **-XGN** 150 psi (10,5 bar)
  - **-XHN** 200 psi (14 bar)

Market: **MOBILE, INDUSTRIAL**	Application: **CYLINDER CONTROL**	Function: **MOTION CONTROL**

Directional Cylinder Control:
XMD-02 for Load-Holding Cylinder Control
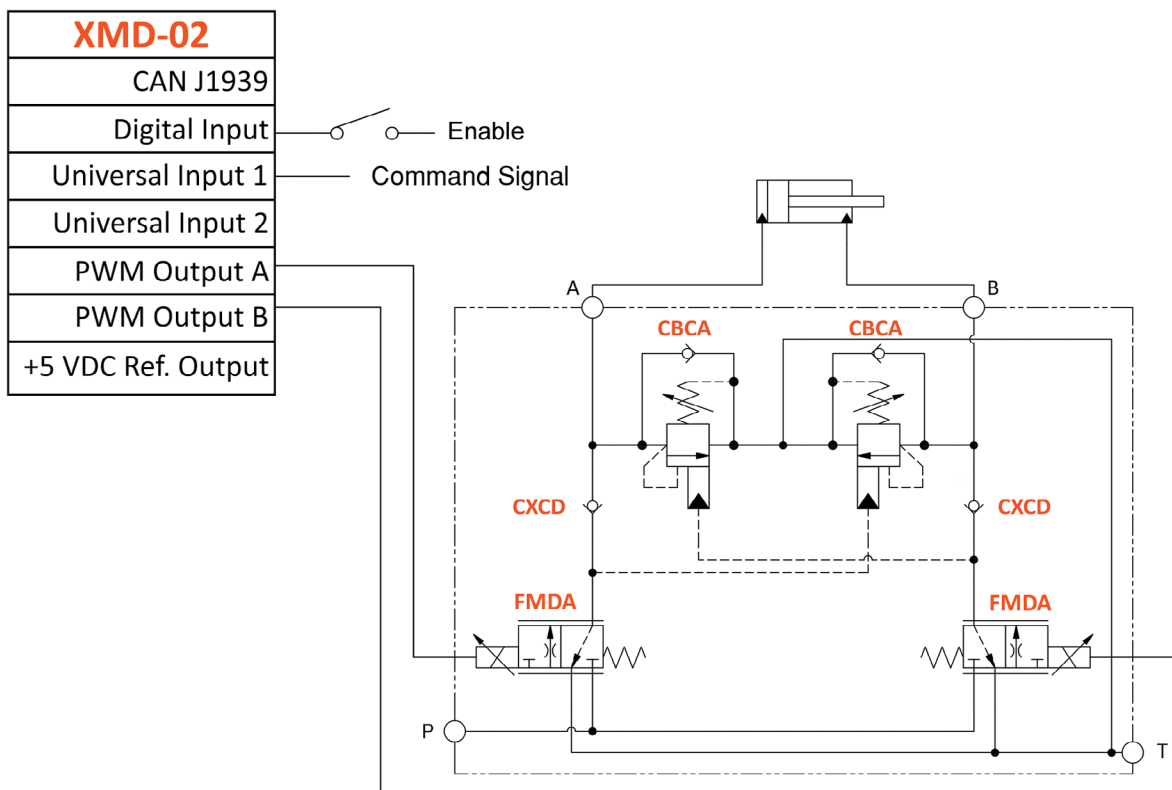
This solution combines the XMD-02 driver with Sun's counterbalance and electro-proportional flow control valves for simple directional control of a cylinder with load-holding capabilities.

In this circuit, the XMD is configured to control two FMDA valves that control the speed and direction of the cylinder using a single input. The two FMDA proportional 3-way valves are used as meter-in elements known as Sun's cushion lock circuit. (The flow path from the two counterbalance valves is from the FMDA work ports to tank.)
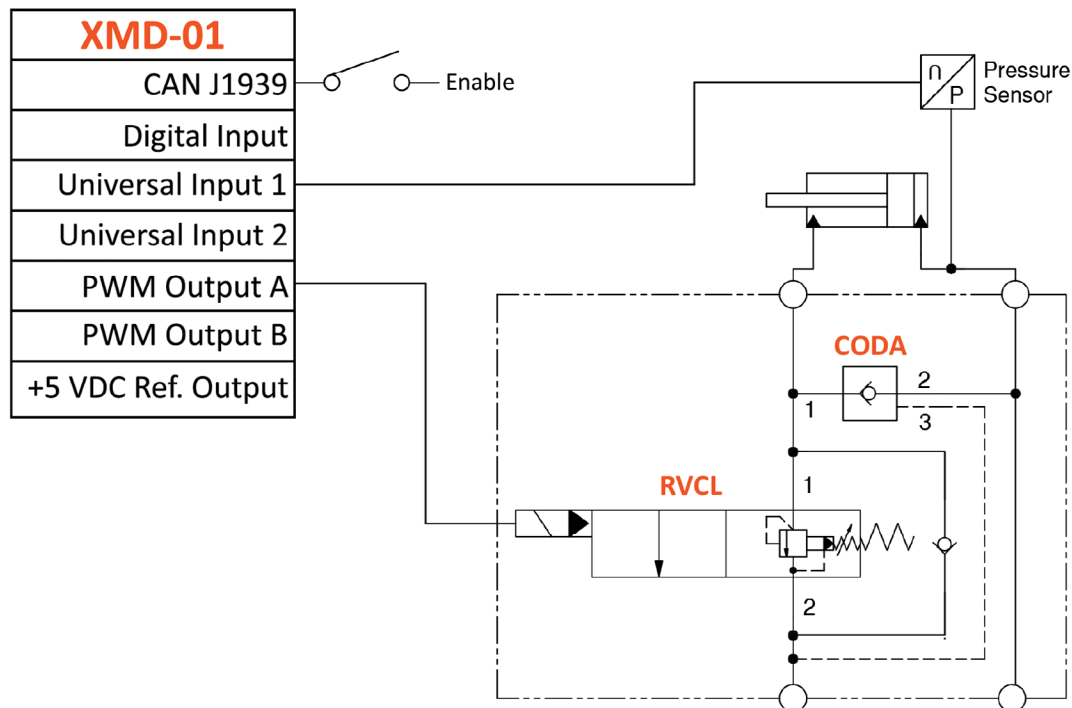
This circuit shows a combination of orifices to reduce the effective setting of pilot pressure (splitter orifice). It also delays the opening of the counterbalance valve. Both help to further dampen the circuit but requires setup time and fine tuning on the machine and does cause leakage.

CAUTION: Small orifices in the pilot line can trap pressure and keep the load-holding valve in an open position. Reverse free-flow check valves are recommended so the load-holding valve can close quickly.

Related Products
- **XMD-02** dual-output driver
- **YCCD** assembly
- Two **A2K** line-mount manifolds
- **FMDA-X*N** - Electro-proportional 3-way flow control valve, meter in
  - **-XAN** 0.1-1.6 gpm (0,4-6,1 L/min)
  - **-XBN** 0.1-4 gpm (0,4-14 L/min)
  - **-XCN** 0.1-6 gpm (1-28 L/min)
  - **-XDN** 0.1-9 gpm (1-40 L/min)
- **CBCA-L*N** - 3:1 pilot-ratio counterbalance valve
  - **-LIN** 400-1500 psi (28-105 bar)
  - **-LHN** 1000-4000 psi (70-280 bar)
- **CXCD-X*N** - Check valve

E-H Solutions

Market:	Application:	Function:
MOBILE, INDUSTRIAL	**RAPID CYLINDER EXTENSION**	**POWER REGENERATION**

Regenerative Assembly:
XMD-01 for Rapid Cylinder Extension

This solution utilizes the same pump flow to double the extension speed of a single-rod cylinder without using a larger pump. To achieve this, oil from the rod end of the cylinder (CR) is added to the pump flow to the blind end (CF), increasing the rate of extension. It incorporates open-loop control using an XMD-01 and a 0–10-Vdc pressure transducer as the sensor feedback.

As the load is engaged and pressure in the blind end rises to the specified pressure, the solenoid valve will be engaged and the regenerative flow will decrease until rod end flow is fully diverted to tank (VR). Full pump pressure is then applied to the blind end, generating maximum force.

NOTE: The ideal cylinder ratio to use with regeneration is 2:1, with the blind end area being twice what the annular area is at the rod end. A 2:1 cylinder in regen gives the same speed extending as retracting.

Related Products

- **XMD-01** single-output driver
- **FAK** line-mount manifold
- **ECK** line-mount manifold
- **RVCL-LJN** - Solenoid-operated, two-stage, field-adjustable pressure relief valve with an operating range of 300–5000 psi (20–350 bar)
- **CODA** - Pilot-to-close check valve

Market:	Application:	Function:
MOBILE, INDUSTRIAL	**PUMP CONTROL**	**TWO-PUMP HIGH-LOW**

Pump Unloading Assembly:
XMD-01 for Two-Pump High-Low Unloading
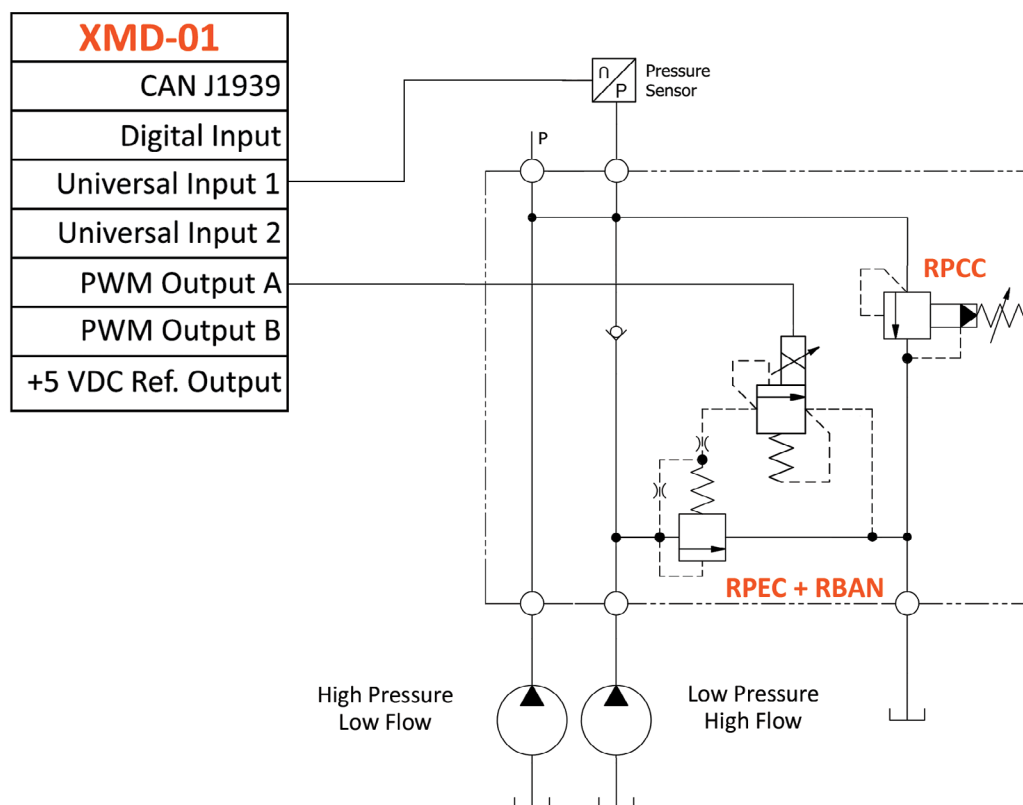
This assembly utilizes a pressure sensor as the system feedback to electro-proportionally control the unloading of a low-pressure/high-flow pump in a two-pump high-low system.

This type of system uses the flow of two pumps to deliver increased speed to an actuator. Once resistance is encountered and the requirement switches from high speed to high force or torque, then the low-pressure/high-flow pump is unloaded back to tank at minimum pressure. At that point, all available horsepower is directed to the high-pressure/low-flow pump.

This assembly also provides a system relief valve. Adding ramps for unload and load functions provides smooth transitions.

Energize the solenoid valve to dump the high-flow, low-pressure pump to tank when the system reaches a specified pressure (High Pressure).

De-energize the solenoid valve to build system pressure at the system-specified low pressure (Low Pressure).

Note: You can use Sun's T-8A pilot cavity concept in this application to achieve greater flow capacities for pressure relief valves.

Related Products

- **XMD-01** single-output driver
- **FAK** line-mount manifold
- **GAL** line-mount manifold
- **AAJ** line-mount manifold
- **RBAN-X*N** - Electro-proportional inverse pressure relief valve
  - **-XDN** 800-300 psi (55-20 bar)
  - **-XBN** 1500-800 psi (105-55 bar)
  - **-XAN** 3000-1500 psi (210-105 bar)
  - **-XWN** 5000-3000 psi (350-210 bar)

E-H Solutions

Market: **MOBILE**	Application: **VARIABLE-SPEED HYDRAULIC FAN DRIVE**	Function: **VARIABLE SPEED**

On-Demand Cooling: XMD-02 for Variable-Speed Hydraulic Fan Drives
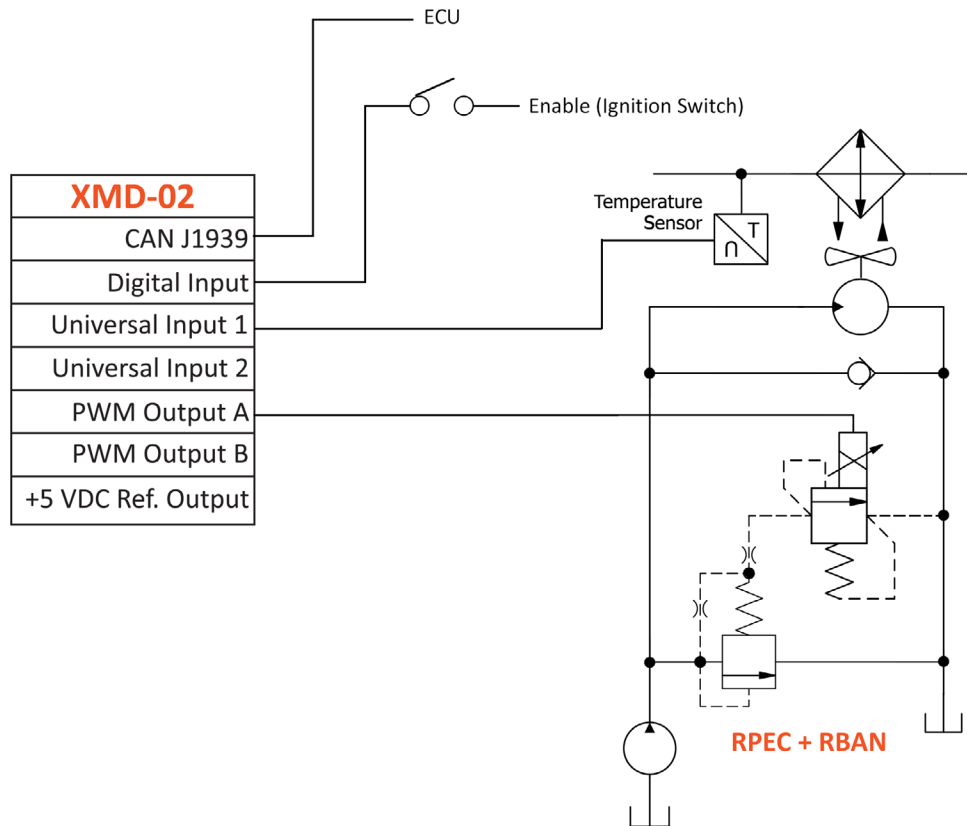
This solution utilizes the XMD-02 to drive Sun's RBAN+RPEC electro-proportional two-stage pressure relief valve that controls fan speed for engine cooling.

In this circuit, the XMD is configured to control electro-proportional relief based on engine coolant temperature reported by the ECU via the J1939 CAN bus. It can also be configured to control the fan speed from the temperature sensor.

Using Sun's CANpoint XMD configuration software, the user can easily configure the XMD to operate as a hydraulic fan drive controller in many applications.

Related Products

- **XMD-02** dual-output driver
- **FAK** line-mount manifold
- **GAL** line-mount manifold
- **RBAN-X*N** - Electro-proportional inverse pressure relief valve
  - **-XDN** 800-300 psi (55-20 bar)
  - **-XBN** 1500-800 psi (105-55 bar)
  - **-XAN** 3000-1500 psi (210-105 bar)
  - **-XWN** 5000-3000 psi (350-210 bar)
- **RPEC-8*N** - Main stage relief
  - **-8DN** 25 psi (1,7 bar)
  - **-8WN** 100 psi (7 bar)
- **CXDA-X*N** - Anti-cavitation check valve
  - **-XZN** 1 psi (0,07 bar)
  - **-XAN** 4 psi (0,3 bar)

Market:	Application:	Function:
MOBILE	**VARIABLE-SPEED REVERSING HYDRAULIC FAN DRIVE**	**VARIABLE SPEED**

On-Demand Cooling: XMD-02 for Variable-Speed Hydraulic Fan Drives with Reversing
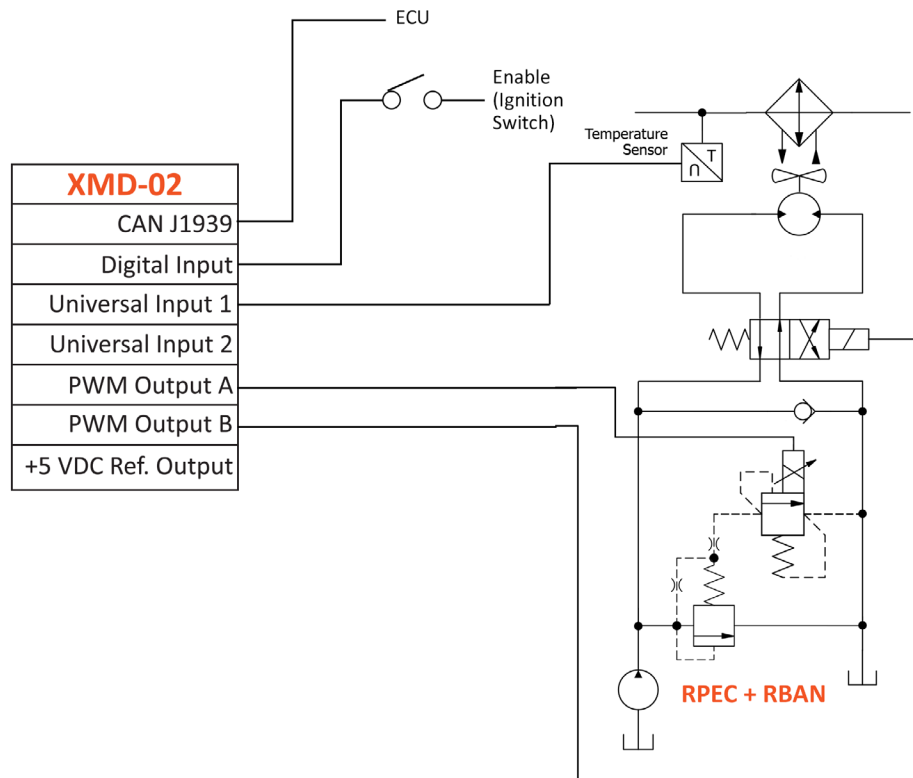
In this solution, the XMD-02 controls fan speed for engine cooling by driving Sun's RBAN+RPEC electro-proportional two-stage pressure relief valve. By adding a 4-way, 2-position directional valve, the user can reverse the motor direction to clear debris from the radiator.

In this circuit, the XMD is configured to control electro-proportional relief based on engine coolant temperature reported by the ECU via the J1939 CAN bus. It can also be configured to control the fan speed or reversing from the temperature sensor.

Using Sun's CANpoint XMD configuration software, the user can quickly and easily configure the XMD to operate as a hydraulic fan drive controller in many applications.

Related Products

- **XMD-02** dual-output driver
- **FAK** line-mount manifold
- **RBAN-X*N** - Electro-proportional inverse pressure relief valve
  - **-XDN** 800-300 psi (55-20 bar)
  - **-XBN** 1500-800 psi (105-55 bar)
  - **-XAN** 3000-1500 psi (210-105 bar)
  - **-XWN** 5000-3000 psi (350-210 bar)

Market:	Application:	Function:
MOBILE, INDUSTRIAL	**CYLINDER CONTROL**	**PID CLOSED-LOOP PRESSURE CONTROL**

Pressure Control: XMD-02 for PID Closed-Loop Pressure Control
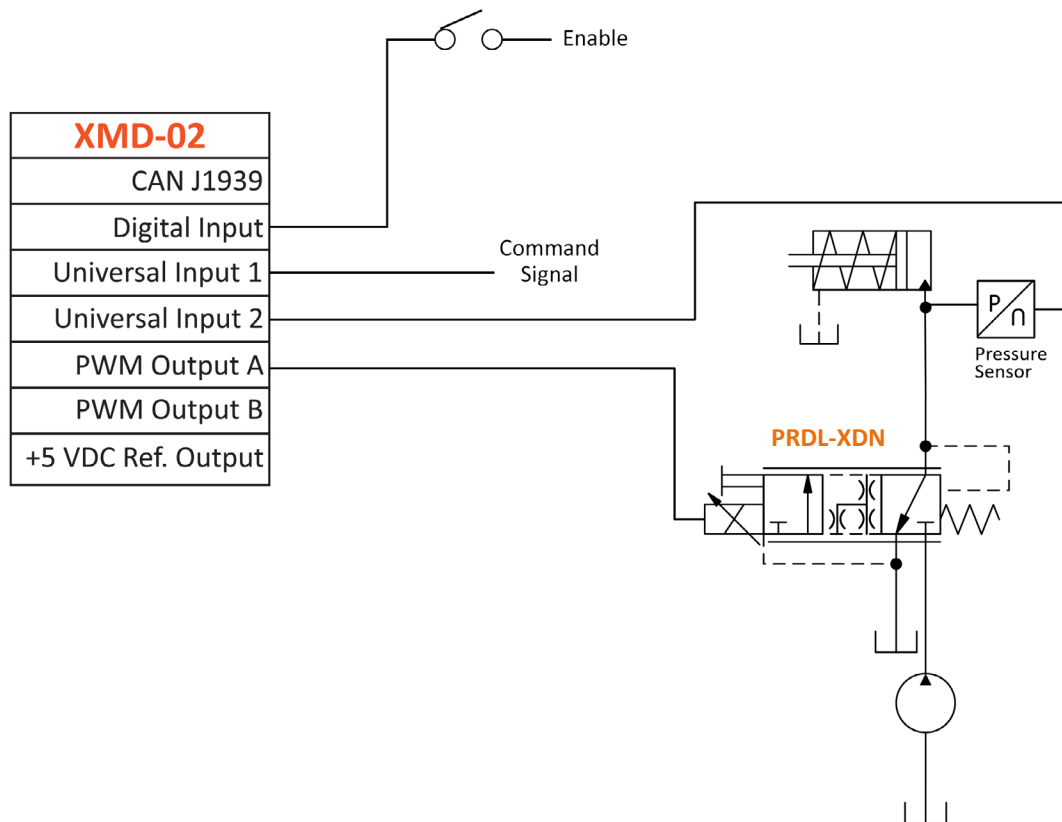
This solution uses the XMD-02 to control the pressure in a single-acting cylinder using Sun's PRDL-XBN electro-proportional pressure reducing/relieving valve.

One common application for closed-loop pressure control is on molding presses. Pressure must be held constant during the curing process. That process can range from seconds to hours, depending on the process and material.

In this example, the XMD is configured to control a single electro-proportional

pressure reducing/relieving valve using command input and feedback input from a pressure transducer.

Using Sun's CANpoint XMD configuration software, the user can configure the XMD to operate as a closed-loop PID controller to control a wide range of electro-proportional pressure control valves. The PID terms are fully configurable by the user.

Related Products

- **XMD-02** dual-output driver
- **A2K** line-mount manifolds
- **PRDL-X*N** - Electro-proportional, direct-acting pressure-reducing/ relieving valve with open transition
  - **-XSN** 10-100 psi (3,5-33,5 bar)
  - **-XEN** 25-250 psi (1,7-18 bar)
  - **-XDN** 50-485 psi (3,5-33,5 bar)
  - **-XBN** 100-1125 psi (7-77,5 bar)

Market: **MOBILE, INDUSTRIAL**	Application: **CYLINDER CONTROL**	Function: **PID CLOSED-LOOP PRESSURE CONTROL**

Position Control:
XMD-02 for PID Closed-Loop Position Control
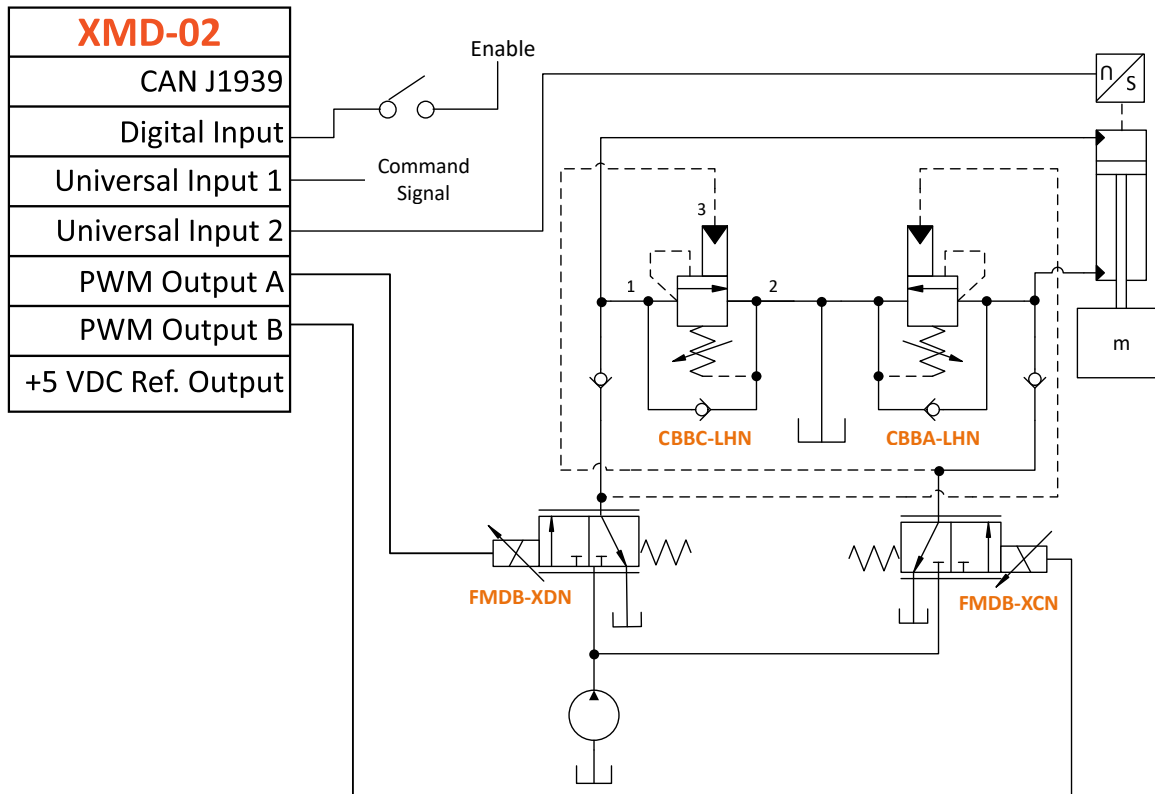
This solution uses the XMD-02 to drive Sun's FMDB-XDN electro-proportional 3-way, 2-position flow control valve to control the position of a double-acting cylinder. Examples using closed-loop position control include industrial presses, processing machinery, test equipment and simulation rides.

Valves can be sized for the correct flow rate based on the cylinder ratio. This aids in stability and control resolution.
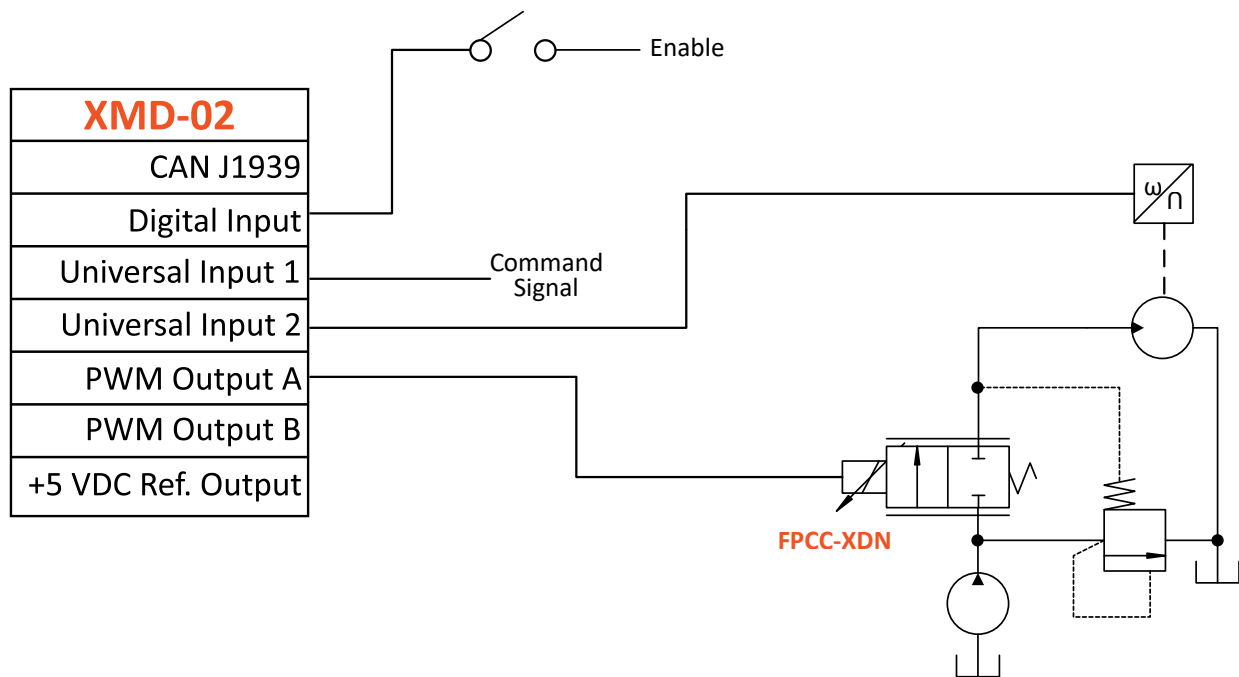
In this circuit, the XMD drives two electro-proportional directional control valves using command input and feedback input from a position transducer.

Using Sun's CANpoint XMD configuration software, the user can quickly and easily configure the XMD to operate as a closed-loop PID controller to control a wide range of electro-proportional directional control valves. The PID terms are fully configurable by the user.

Related Products

- **XMD-02** dual-output driver
- **YCCD** assembly
- Two **A2K** line-mount manifolds
- **FMDB-X*N** - Electro-proportional 3-way flow control valve, meter in
  - -**XAN** 0.1-1.6 gpm (0,4-6,1 L/min)
  - -**XBN** 0.1-4 gpm (0,4-14 L/min)
  - -**XCN** 0.1-6 gpm (1-28 L/min)
- **CBBC-L*N** - Semi-restrictive, 3:1 pilot-ratio counterbalance valve
- **CBBA-L*N** - Fully restrictive, 3:1 pilot-ratio counterbalance valve

E-H Solutions

Speed Control:
XMD-02 for PID Closed-Loop Speed Control

This solution uses the XMD-02 to control the speed in a hydraulic motor using Sun's FPCC-XDN electro-proportional flow control valve. A good application of closed-loop speed control is on a lathe that cuts the veneers of wood that are then pressed into plywood. Speed must be held constant during the cutting process.

In this circuit, the XMD is configured to control a single electro-proportional flow control valve using command input and feedback input from an encoder.

Using Sun's CANpoint XMD configuration software, the user can configure the XMD to operate as a closed-loop PID controller to control a with a wide range of eletro-proportional pressure control valves. The PID terms are fully configurable by the user.

Related Products

- **XMD-02** dual-output driver
- **A3L** line-mount manifold
- **FPCC-X*N** - Electro-proportional directional valve
  - -**XAN** 0.1-1.5 gpm (0,4-5,7 L/min)
  - -**XBN** 0.15-3.5 gpm (0,6-14 L/min)
  - -**XCN** 0.25-7 gpm (1-28 L/min)
  - -**XDN** 0.25-10 gpm (1-40 L/min)

Resources on the Sun Hydraulics Website

To learn more about the products featured in these electro-hydraulic solutions, please visit our website – SunHydraulics.com. Enter the product model code in the site search to find technical specifications and drawings.

Beyond the valves included in these solutions, Sun Hydraulics offers more than 80 solenoid-operated valves – directionals, proportionals and reliefs – for a wide range of applications.

Also available are product specifications, application information and videos on the XMD-01 and -02 and support information for the CANpoint XMD Configuration Software. See specific references below.

XMD Valve Driver

- XMD-01 Product Page: https://www.sunhydraulics.com/model/XMD-01
- XMD-02 Product Page: https://www.sunhydraulics.com/model/XMD-02
- XMD Overview Article: https://www.sunhydraulics.com/XMDOverview
- XMD Installation Instructions: https://www.sunhydraulics.com/XMD_Installation.pdf
- XMD Mobile App User Manual: https://www.sunhydraulics.com/XMD_Mobile_App.pdf

CANpoint XMD Configuration Software

- Software Registration & Download: https://www.sunhydraulics.com/software-registration
- CANpoint Overview Article: https://www.sunhydraulics.com/about/highlights/canpoint-xmd-configuration-software
- CANpoint Quick Start Guide: https://www.sunhydraulics.com/sites/default/files/media_library/tech_resources/CANpoint_QuickStart_999901857.pdf

Electro-Hydraulic Valves

- FLeX Series Solenoid-Operated Valve Family: https://www.sunhydraulics.com/FLeX
- Electro-Hydraulic Valves: https://www.sunhydraulics.com/models/cartridges/solenoid-operated
- Electro-Proportional Valves: https://www.sunhydraulics.com/models/cartridges/electro-proportional

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