CANPOINT

XMD Configuration Software

Quick Start Guide

PID Closed-Loop Control and Hydraulic Fan Control

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1. Connecting to the XMD

This Quick Start Guide is designed to help the user apply the complete functionality of the XMD-02 Hydraulic Valve Driver in applications using the CANpoint XMD Configuration Software. With seven different universal and CAN inputs available, the XMD-02 provides significant flexibility in a compact, rugged package.

CANpoint can be used to communicate with either an XMD-01 or XMD-02 (with firmware and bootloader at the minimum revision or higher). The XMD-02 dual-output driver offers additional functionality of closed-loop PID and hydraulic fan control along with open-loop control.

The use of CANpoint with the XMD requires the CAN-to-USB adapter ECom dongle (Sun Hydraulics part number 991-728) to connect your PC to the XMD (Fig. 1). Be sure the 120-Ω resistor is installed in the 3-way Deutsch receptacle. Plug the USB cable into your computer and start CANpoint. CANpoint or the XMD Mobile App can be used to connect to the XMD, but both cannot be used simultaneously.

Note: CANpoint only operates at 250-kBaud rate. If the baud rate for the CAN bus is not 250 k, it will need to be changed to 250 k with the XMD Mobile App before CANpoint can be used for that bus. The baud rate can be changed back to its original value after the work with CANpoint is completed.

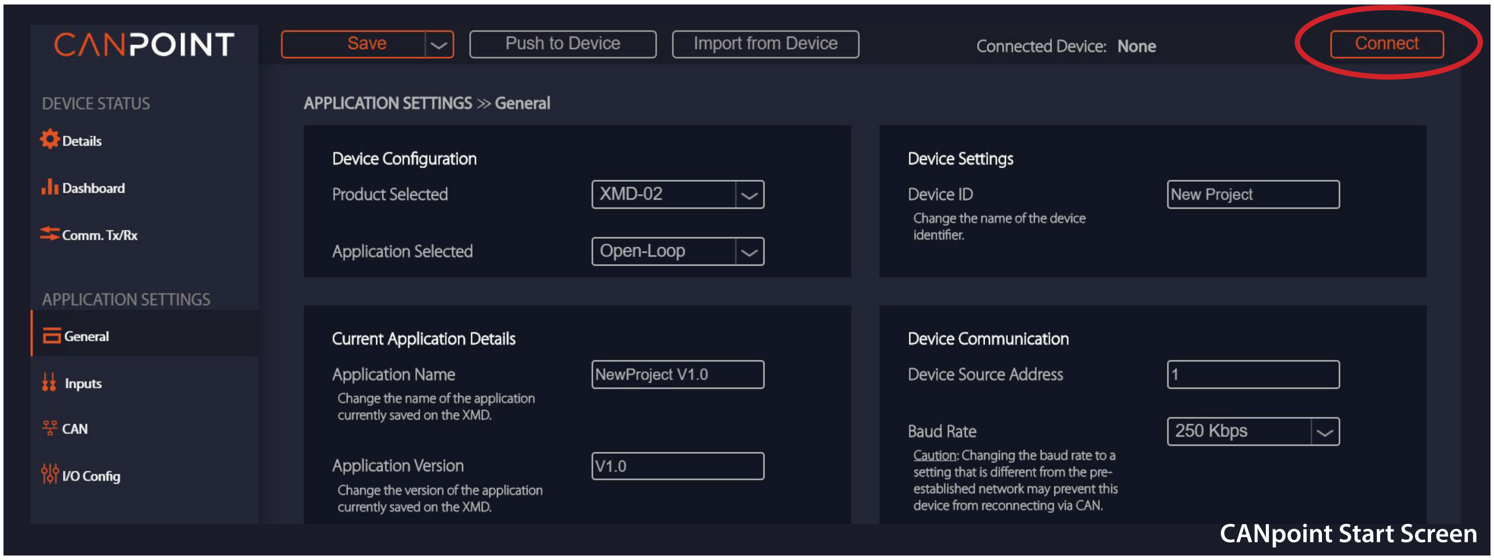
To register and download CANpoint, go to SunHydraulics.com/software-registration

Hardware & software requirements:

- **XMD firmware: V2.16 or higher**
- **XMD bootloader: V2.02 or higher**
- **Windows 10**

Fig. 1

When CANpoint opens, it starts on the General screen (as shown below). With the CAN-to-USB adapter connected to a powered XMD and plugged into the computer, press the Connect button to open the Scan page.



CANpoint Start Screen

1. Connecting to the XMD (continued)

Pressing the Scan button will show all the XMDs connected to the CAN network (Fig. 2).

Pressing the Connect button will establish the link between CANpoint software and the XMD that you are setting up. Note that if there are multiple XMDs on the network, the one that is linked to CANpoint will have a flashing green COMM/Fault LED (see "LED Operation" on page 19).

Clicking on I/O Config allows you to find the Input-to-Output Configuration (Fig. 3). Clicking in the box opens a dropdown that shows the modes available. The XMD-01 only has Open-Loop. The XMD-02 has Open-Loop, PID, and Hydraulic Fan Drive modes available.

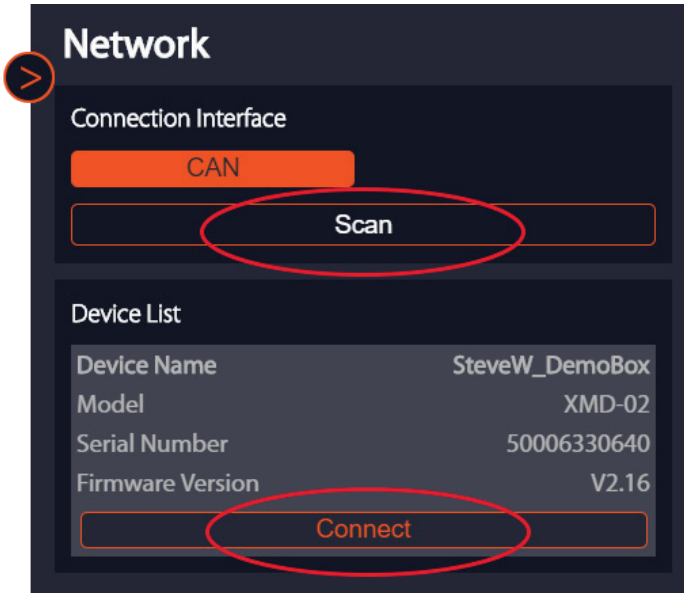


Fig. 2

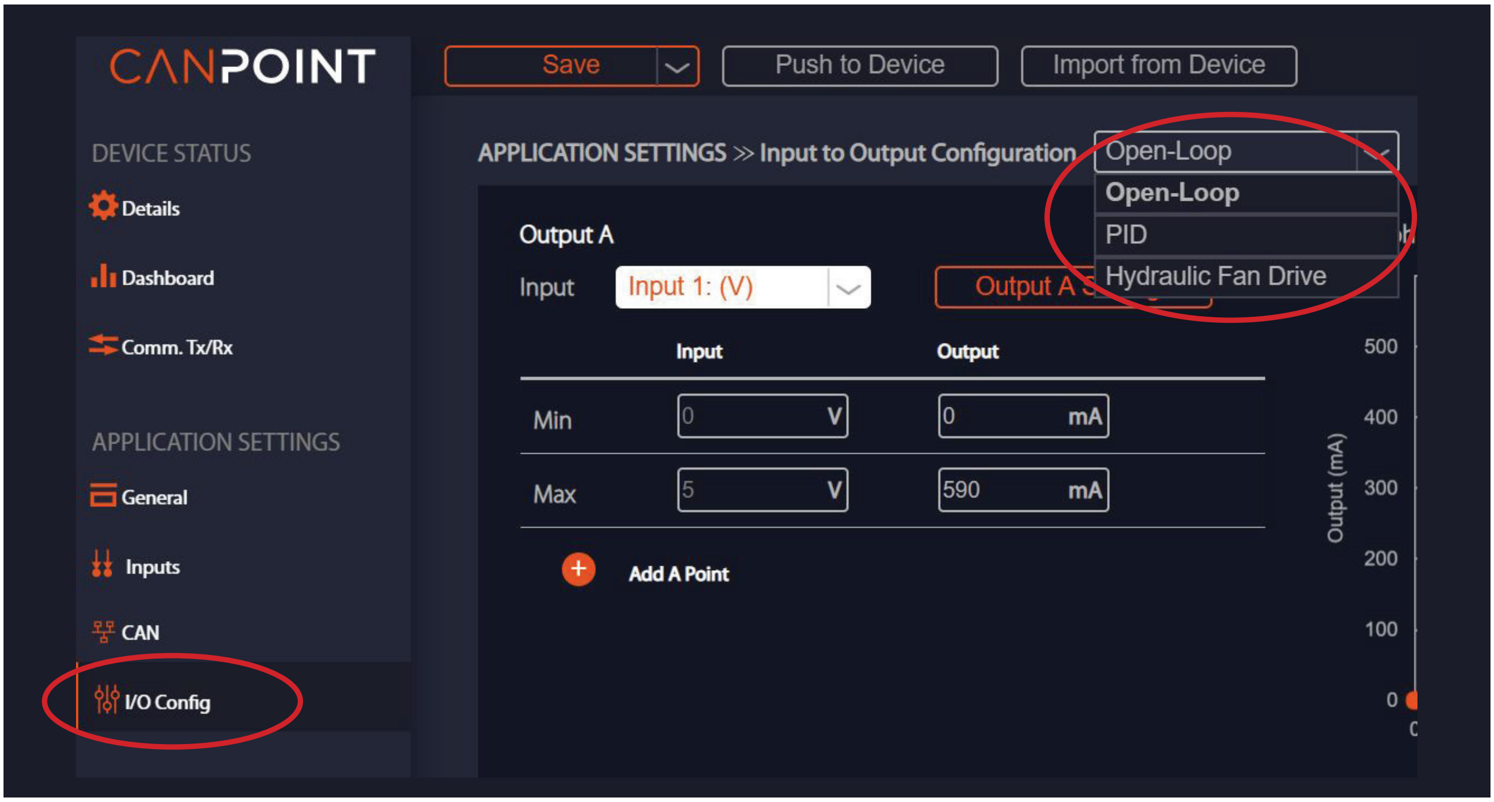


Fig. 3

1.1 Electrical Connections

The XMD-02 has two universal inputs and three CAN inputs. Any combination of the inputs can be used to set-up the PID closed-loop or the hydraulic fan control.

The universal inputs can be configured as shown in the table below (Fig. 4) and can be configured with engineering units.

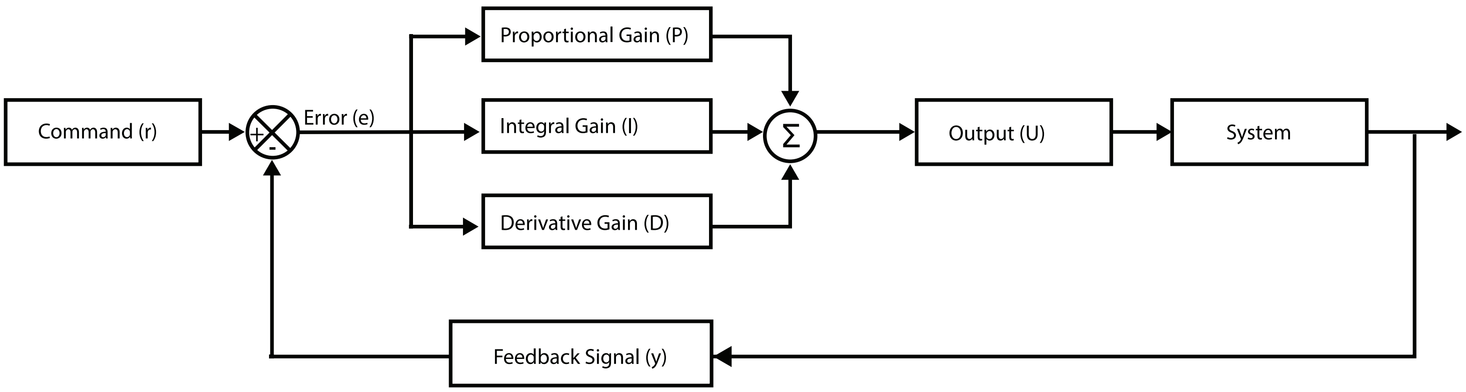
Input Type	Range	Default Error Low	Default Error High
0-5 V	0-5	-1.1 Vdc	5.1 Vdc
0-10 V	0-10	-0.1 Vdc	10.1 Vdc
4-20 Ma	4-20	3.8 mA	20.5 mA
PWM	60 Hz - 10kHz	-1%	101%
Frequency	60 Hz - 10kHz	59 Hz	10,100 Hz
Resistive	0-100,000 Ω	-1 Ω	100,100 Ω
Digital	0 to +Supply	None	None

Fig. 4

Pin No.	XMD Function
1	CAN Low
2	CAN High
3	GND (Output and 5 Vref)
4	XMD-01 No Connection XMD-02 PWM Output Coil B
5	GND (Output and 5 Vref)
6	PWM Output, Coil A
7	Batt GND
8	+V Batt
9	Enable
10	+5 Vref
11	Universal Input 1
12	XMD-01 No Connection XMD-02 Universal Input 2

The XMD can be configured to use the Universal Inputs as shown in the table in Figure 4. Additionally, the XMD can be configured to receive up to three CAN J1939 messages that can also be used as inputs. A properly configured J1939 CAN must be available on the machine in order to make use of these CAN messages for controlling the XMD. The XMD acts as a node on the CAN and will transmit the analog inputs from the Universal Inputs onto the CAN. For example, the XMD can be configured to receive inputs from a CAN joystick and an analog pressure transducer on one of the Universal Inputs. The pressure transducer output would be reported by the XMD on the CAN Transmit messages.

2. PID Closed-Loop Control



In the I/O Config tab, select PID under the Input-to-Output Configuration and then select PID Settings to open the Output PID panel (Fig. 5). This is where values for the Proportional, Integral, and Derivative gains are entered. The default values for the gains is 0. Without tuning the P, I, or D gains, the output will be zero.

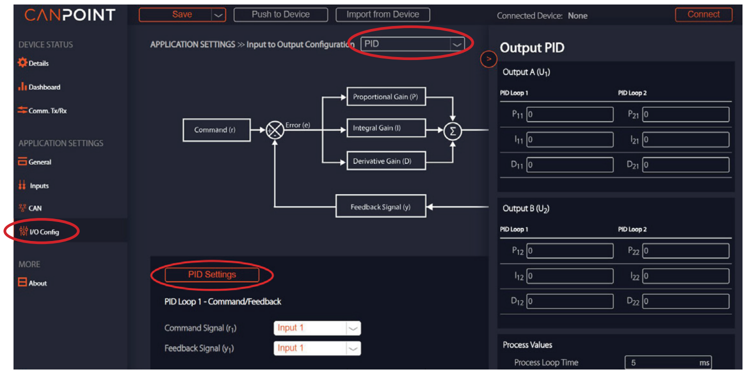


Fig. 5

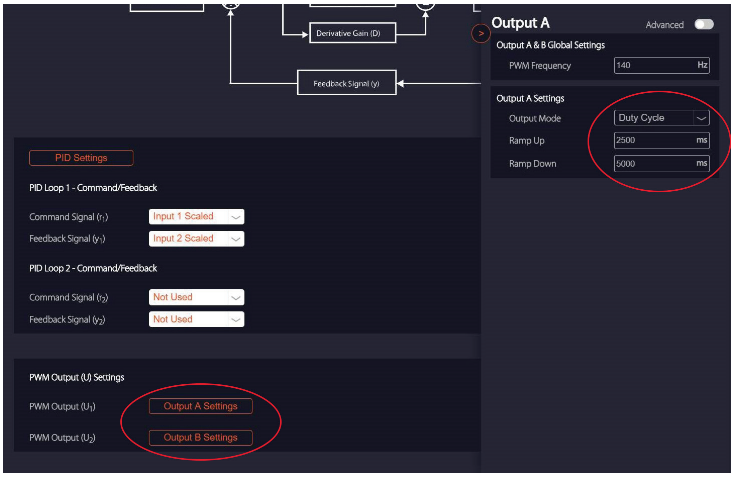


Fig. 6

The output mode of the solenoid coils must be changed from the default Current Regulation to Duty Cycle for the PID closed-loop control to function properly (Fig. 6). If using two coils in PID mode, the output mode must be changed for both Output A and Output B.

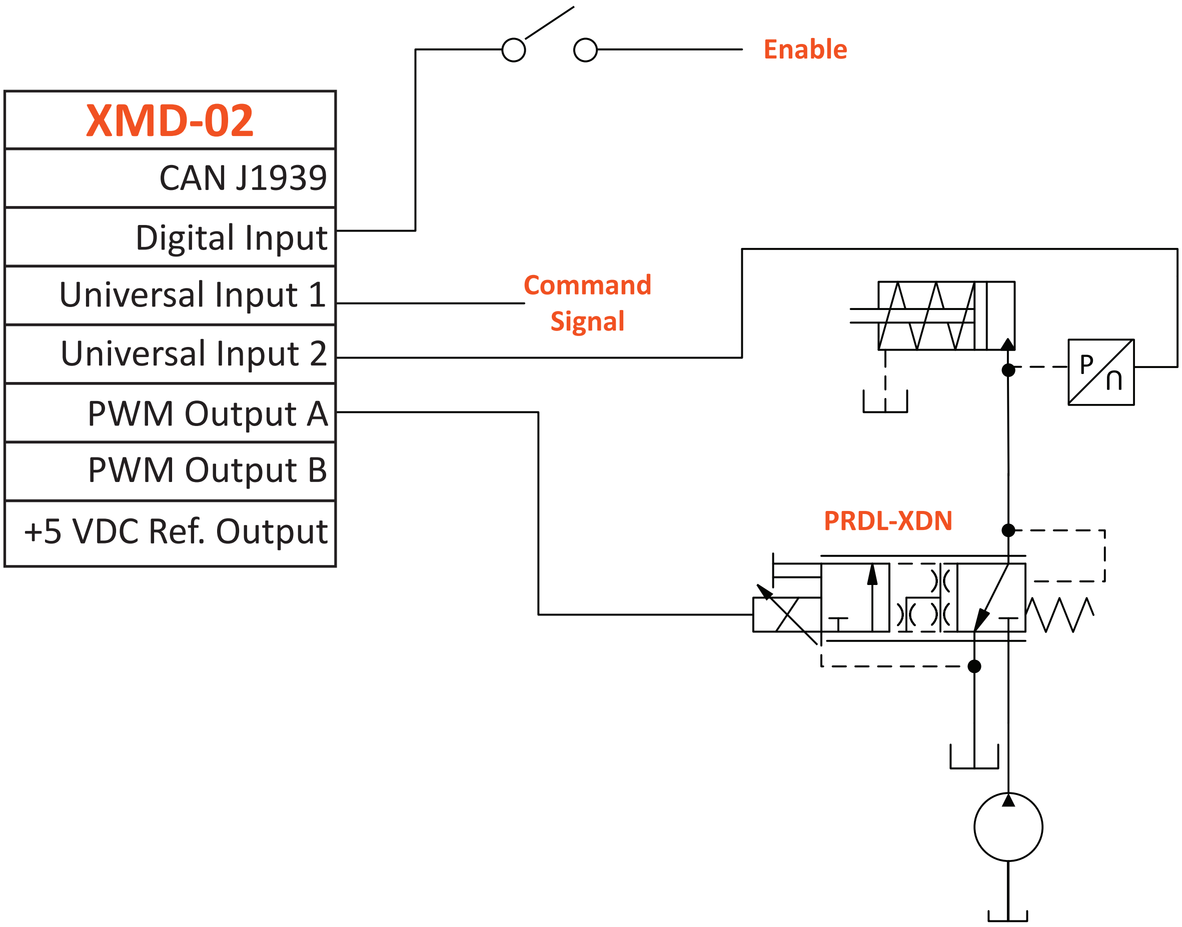
The XMD-02 is now set-up in closed-loop PID mode. Remember that the P, I, and D gains need to be tuned.

At least one must be tuned for the XMD-02 to output current to a solenoid coil.

It is important for the user to understand the effect of the P, I, and D gains, and there are numerous resources online to explain the effect. In addition, tuning methods for PID controllers are also available online. It is important that the user understand how to use these methods to calculate the P, I, and D gains. Keep in mind that these methods provide a starting point for the tuning and that further adjustment might be necessary.

2.1 Pressure Control

This example illustrates closed-loop pressure control using a pressure reducing/relieving valve to control the force of a single-acting cylinder. The feedback device is a pressure transducer. While this example and results are for a pressure reducing/relieving valve, the process can be applied to pressure controls in general.



2.1 Pressure Control (continued)

See Fig. 7 for sample tuning applied in the pressure control example on page 6.

The sample tuning in Fig. 7 produces step response results below (Fig. 8). Note that the tuning can be P, PI, and PID. In most applications, P or PI tuning is sufficient to achieve the desired results.

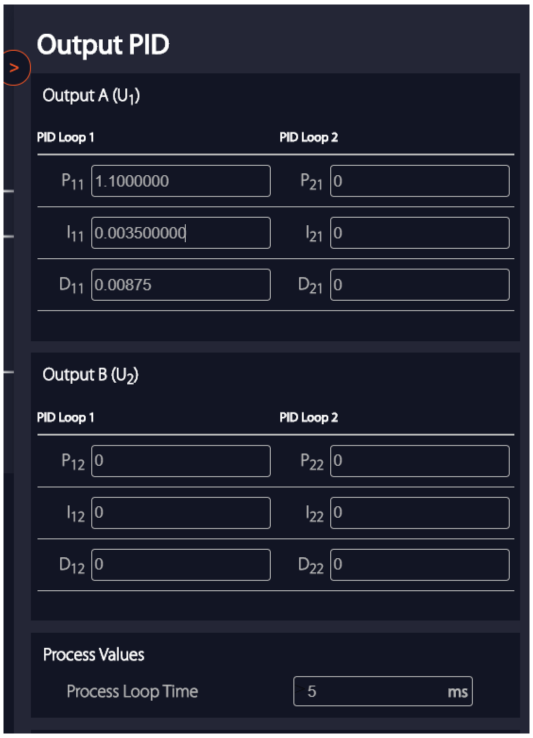


Fig. 7

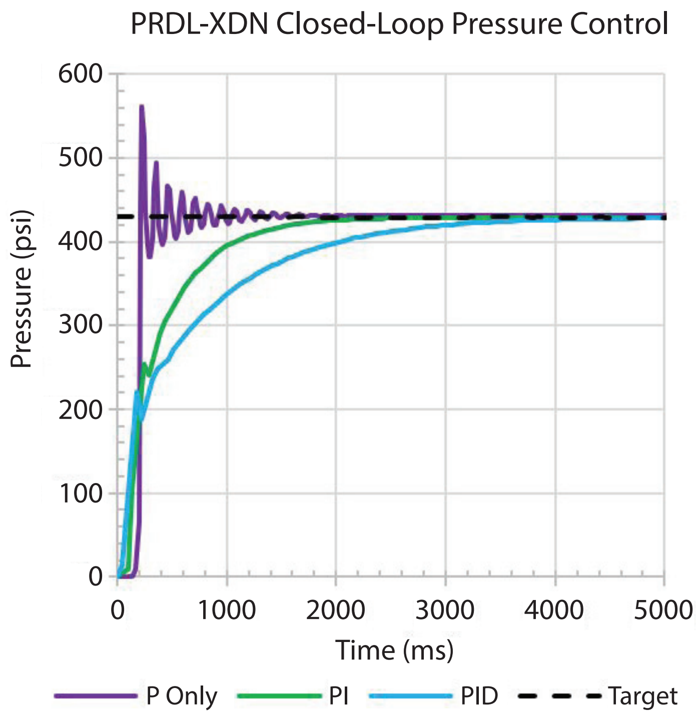
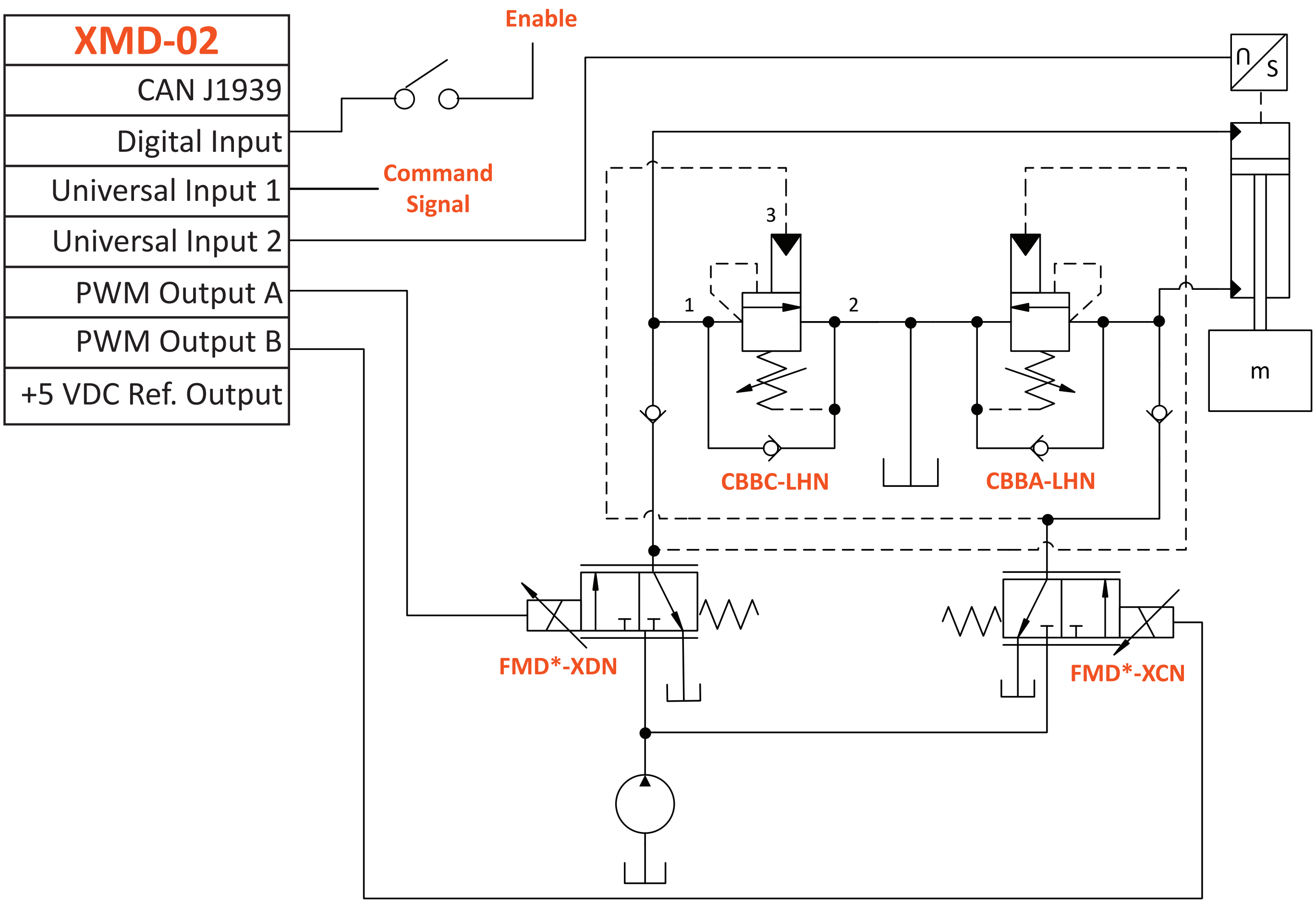


Fig. 8

2.2 Position Control

In this example, the XMD-02 is used for position control of a double-acting cylinder. The feedback device is an LVDT. The sample circuit shows two 3-way, 2-position proportional directional valves being used to make the function of a 4-way, 3-position directional valve. A 4-way, 3-position proportional directional valve can also be used.



2.2 Position Control (continued)

A PI sample tuning for position control is shown below (Fig. 9). It is important to note that when using the XMD-02 for position control with two solenoids (whether a 4/3 or two 3/2 valves), the negative gains for one of the outputs is necessary. For the example, tuning of the gains are identical aside from the negative sign. They do not need to be. It might be necessary to use different gains to account for the cylinder ratio.

The sample tuning in Fig. 9 produces the step response results below (Fig. 10).

Fig. 9

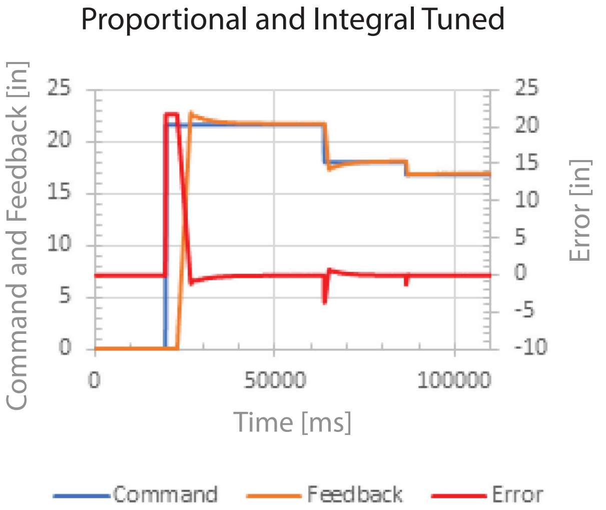


Fig. 10

Pub. #999-901-857

2.3 PID Tuning Tips

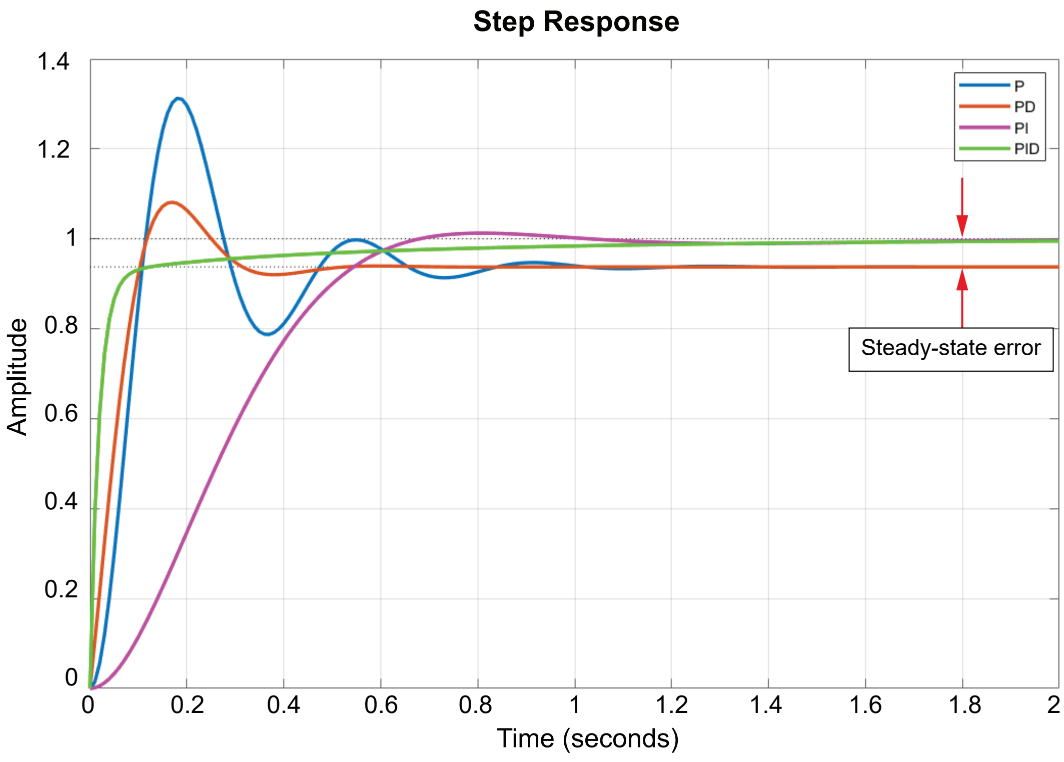
Proportional gain, P, acts to push the system. The higher the P gain, the harder the push. The closed-loop system will react faster but overshoot more. P will also tend to reduce error but not eliminate it. Integral gain, I, tends to reduce steady state error. Derivative gain adds the ability to anticipate error by increasing its effect as the error increases and decreasing as the error gets smaller. This effect also tends to dampen the system which also reduces the overshoot. D gain does not affect the steady state error. This is shown in the graph below and summarized in the table on the following page.

In place of model-based tuning or formal tuning method, start with Proportional gain. Increase the P gain until the system oscillates. This can be seen in the Data Graph on the Dashboard tab. Reduce the P gain to the previous value. If this tuning has an unacceptable error, add Integral gain. Generally, I gain is going to be much smaller than P gain. Follow the same procedure as before, incrementing I gain until the system oscillates. Go back to the last good I gain value. If the error is acceptable, tuning is complete. P and PI controllers are very common. If the error is still unacceptable, add Derivative gain. Again, D gain is going to be much smaller than P gain.

An I gain-only control is a perfectly valid control. An example of when this might be needed is a pressure control application that does not need relatively fast response but cannot tolerate any overshoot.

Changing the process loop time changes the frequency that the error correction calculated by the PID algorithm is applied. Changing the process loop time can help stabilize a system. However, shortening the time too small might not have the desired results. Keep in mind that there is a limit to the speed of response of the system.

Adding a short ramp time can help stabilize a system. Instead of stepping to a commanded response, a short ramp can help minimize the disturbance caused by a



2.3 PID Tuning Tips (continued)

change in command or error correction. Ramps can also be useful in minimizing overshoot and subsequent ringing in the response.

There is a data-logging function available on the Dashboard tab. The function records parameters in a comma-delimited file that can be loaded into a spreadsheet for further analysis. Time-based data is recorded for the universal inputs, CAN receive inputs, and the outputs. Data is recorded as fast as the CAN bus traffic allows.

Transducer selection for feedback is pivotal for successfully applying closed loop control. Transducers should be sized for the range of variable they are controlling. However, some oversizing might be necessary if the variable range does not fit within a standard range transducer. Also, some oversizing is recommended if overpressure or overspeed are possible and would damage the transducer during the tuning process.

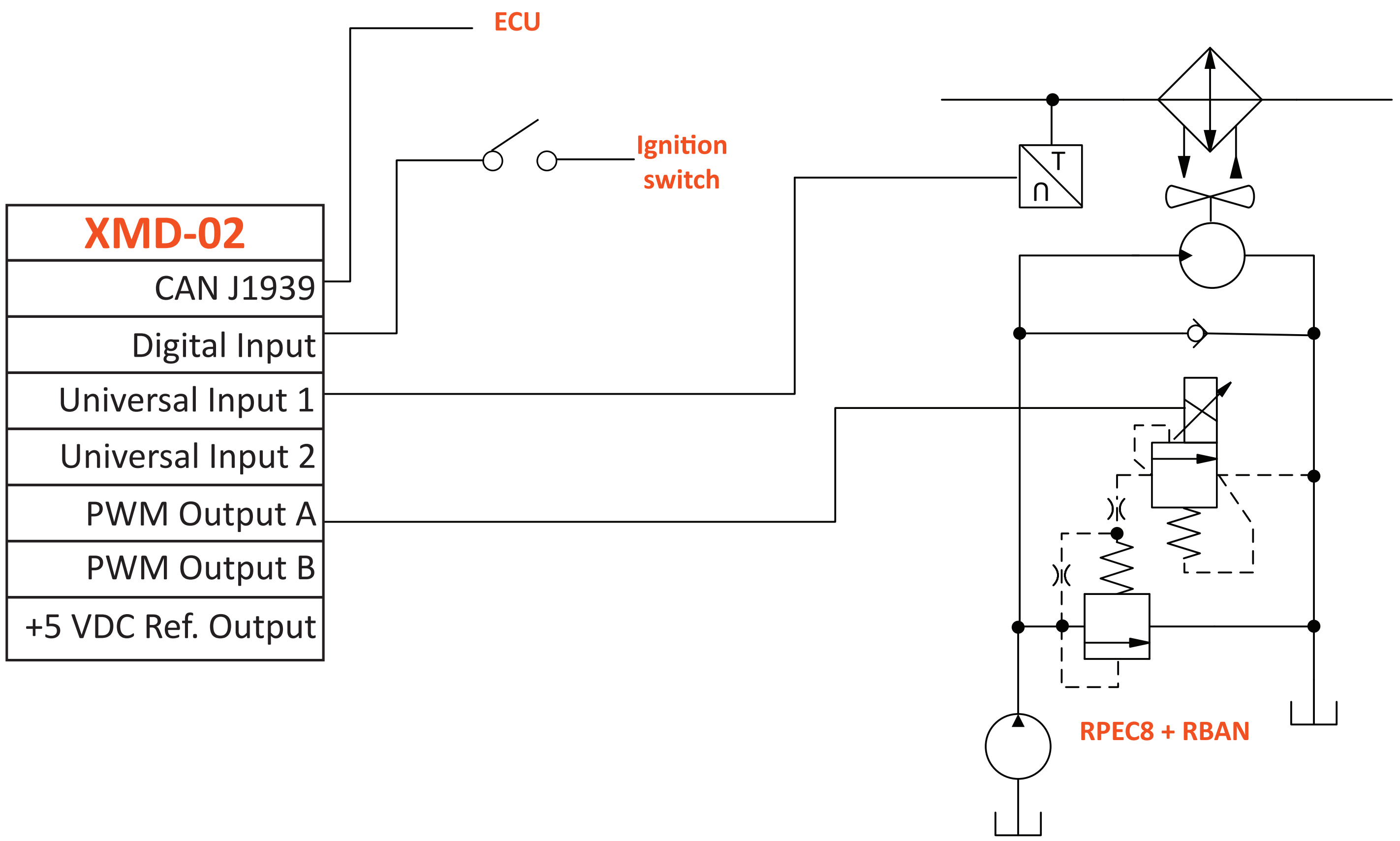
Gain Response	Rise Time	Overshoot	Settling Time	Steady-State Error
P	Decrease	Increase	Small change	Decrease
I	Decrease	Increase	Increase	Eliminate
D	Small change	Decrease	Decrease	No change

Pub. #999-901-857

3. Hydraulic Fan Control

3.1 Typical Hydraulic Fan Control

A typical hydraulic fan drive schematic is shown below. This circuit does not provide for reversing to clear debris that might accumulate on the radiator.



3.1 Typical Hydraulic Fan Control (continued)

An XMD-02 set-up as a Hydraulic Fan Control is shown below in Fig. 11.

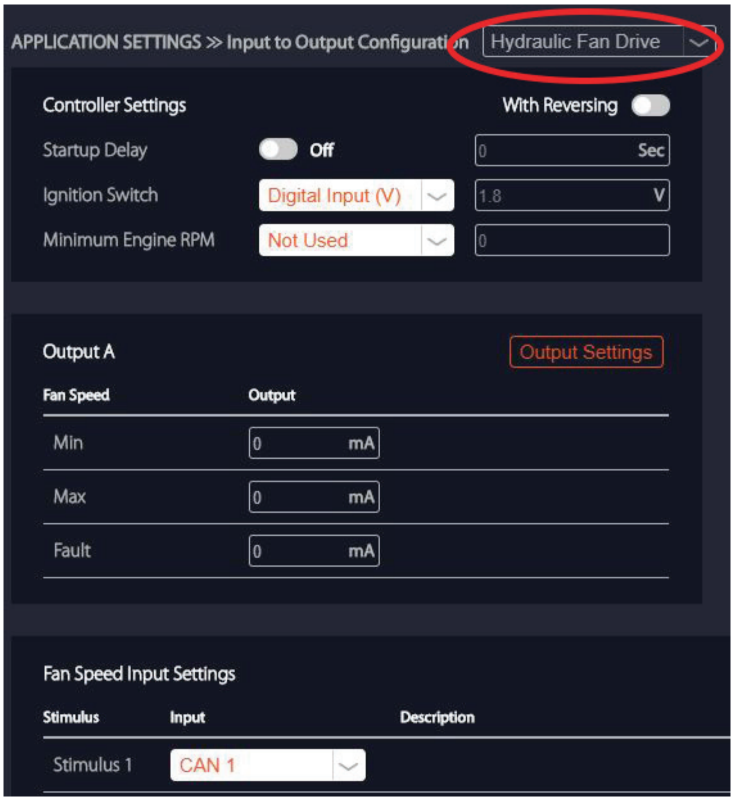
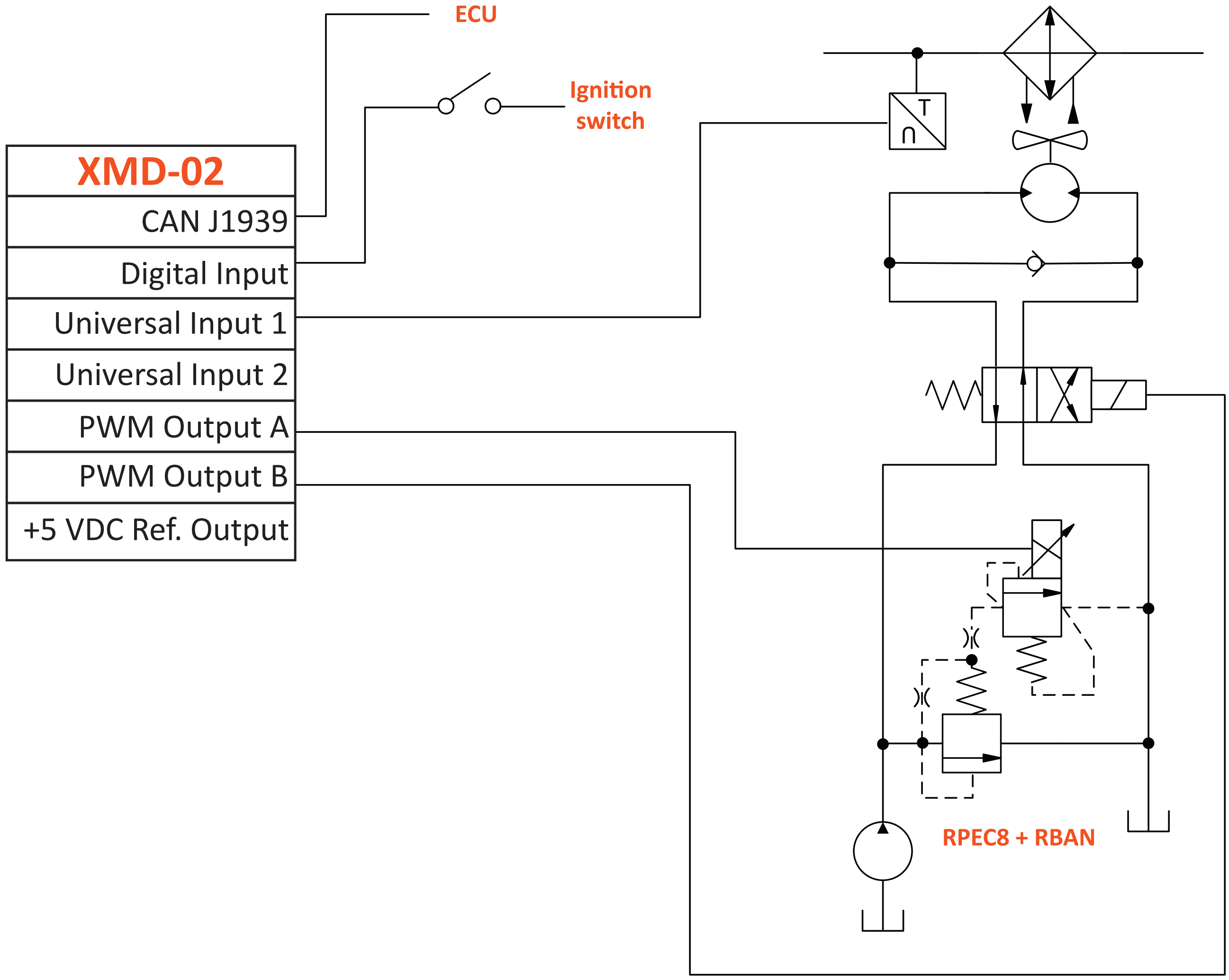


Fig. 11

In this example, the stimulus is the engine coolant temperature received via the CAN bus. As can be seen on the I/O Config tab, there is the possibility of five stimulus channels via the two universal inputs and three CAN bus inputs.

3.2 Hydraulic Fan Control with Reversing

The schematic below is an example of a hydraulic fan drive with reversing. This circuit allows for the fan motor to be reversed in order to clear debris that might accumulate on the radiator. This is typical in construction and agriculture vehicles.



3.2 Hydraulic Fan Control with Reversing (continued)

An XMD-02 set-up as a Hydraulic Fan Control with auto-reversing is shown below in Fig. 12.

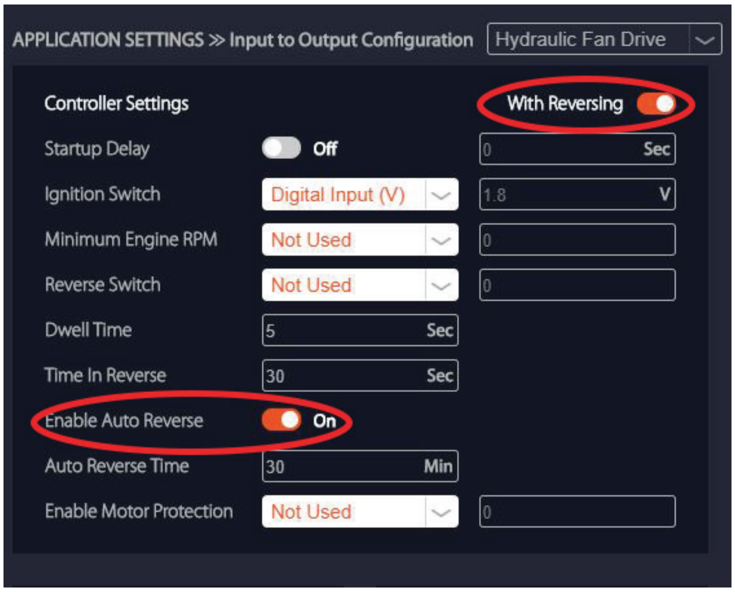


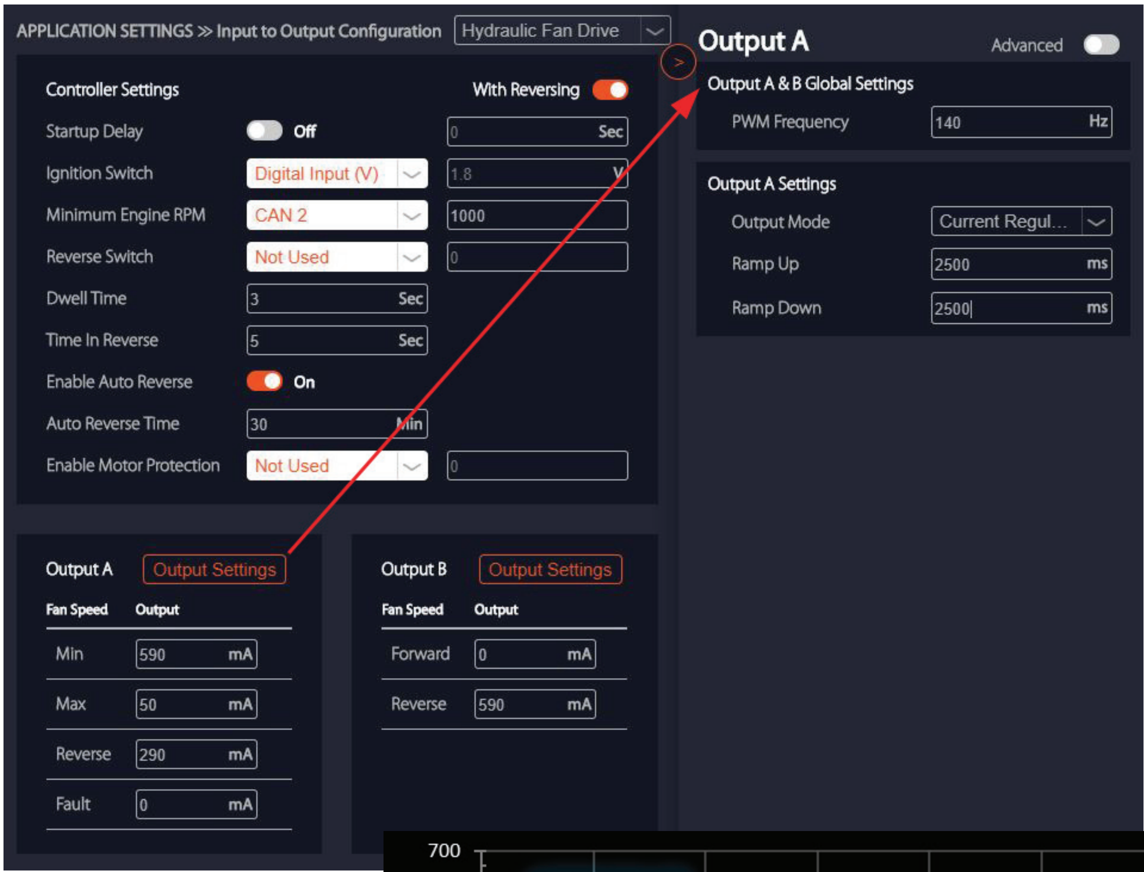
Fig. 12

Auto Reverse Time is a timer that starts the auto-reverse process. The dwell time is the time the fan motor will be paused between forward and reverse to allow the fan to slow down or stop before changing direction of rotation.

Output A is for the inverse proportional relief. Maximum fan speed is achieved with minimum current, and minimum fan speed is achieved with maximum current. Output A can control reverse fan speed by setting a Reverse current value. Keep in mind that the higher the current, the lower the fan speed. Output B is to control the reversing valve. Depending on the valve used, a Forward current value might be needed. For the 4-way, 2-position shown, just a current value to shift to Reverse is needed.

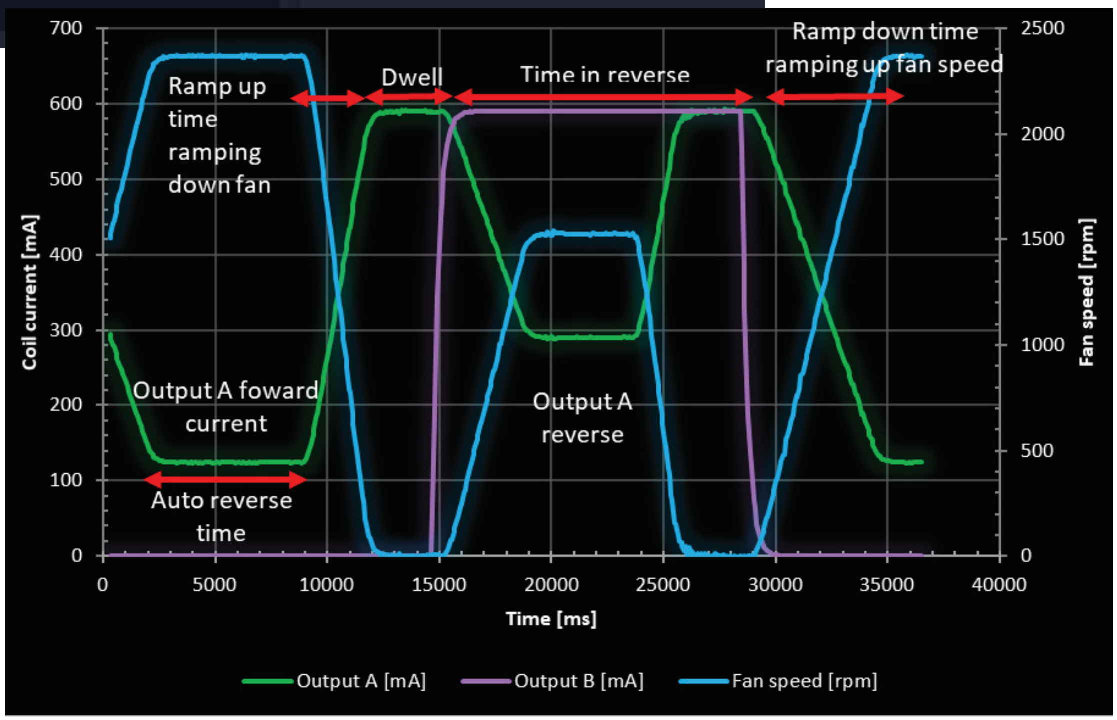
The fan speed can be ramped up and down by adding ramps. Select Output A and Output B then add ramp times. This makes start-up and shut down softer.

3.2 Hydraulic Fan Control with Reversing (continued)



Note: Selecting Hydraulic Fan Drive adjacent to Application Settings will display this screen in the I/O Config tab.

Note: The values used in this fan drive with auto-reverse are for illustration only. Follow the OEM recommendation for proper engine operating temperatures.



3.2 Hydraulic Fan Control with Reversing (continued)

With Reversing toggle sets up the controller to allow the fan motor to be reversed for debris removal.

Startup Delay provides a momentary delay for engine startup without causing a hydraulic load on the engine.

Ignition Switch sets the controller to low fan speed unless the input option selected is above the value specified. If the ignition switch is used, minimum RPM must also be used. Also, if minimum RPM is used, the ignition switch must be used.

Reverse Switch uses one of the inputs to trigger the fan reverse cycle when the value is above that specified.

Dwell Time is time at high output on A to allow the fan to coast to a slower speed or stop before reversing the direction of rotation. Minimum dwell time allowed is 0.1 s.

Time in Reverse is the time specified for the fan to run in reverse for debris removal. The fan speed in reverse is controlled by the Reverse current under Output A. Time in reverse should not be set to 0.

Enable Auto Reverse toggle causes the controller to run the reverse fan cycle after the time specified in the **Auto Reverse Time**.

Enable Motor Protection provides an option to use an input signal on the fan motor to be certain that the motor is stopped or turning at slow speed before reversing direction of rotation.

Output A

Min Fan Speed is the current output on A to reach minimum fan speed. With an inverse-acting valve, this would be the maximum current. By selecting **Output Settings**, a ramp up in current (for an inverse acting valve) can be set for the controller to ramp up the current to produce a smooth slowdown of the fan.

Max Fan Speed is the current output on A to reach maximum fan speed. With an inverse-acting valve, this would be a minimum current. By selecting **Output Settings**, a ramp down in current (for an inverse-acting valve) can be specified for a smooth increase in fan speed.
Reverse Fan Speed sets the output current on A when in the reverse direction. Ramps from the output settings are used.

Fault Fan Speed sets the output current on A if there is a fault detected in the controller. It is advisable to consider a fail in a safe mode – e.g., maintain engine cooling if a fault develops.

Output B

Forward Fan Speed specifies the current output on coil B needed to achieve forward fan speed. If a 4/3 directional valve is used as the reversing valve, a forward current might need to be specified.

Reverse Fan Speed specifies the current output on coil B to switch the flow direction to the fan motor. Typically, a 4/2 directional valve is used as the reversing valve, and reverse fan speed current is the current needed to energize the solenoid of this directional valve.

Ramps are not used on Output B.

Fan Speed Input Settings

Stimulus	Input	Description	Minimum Setpoint	Maximum Setpoint	Fault Low	Fault High
Stimulus 1	CAN 1		0	190	-1	256
Stimulus 2	Not Used		0	10	0	0
Stimulus 3	Not Used		0	0	0	0
Stimulus 4	Not Used		0	0	0	0
Stimulus 5	Not Used		0	0	0	0

In Hydraulic Fan Control, toward the bottom of the of the I/O configuration page, five stimulus channels are available (2 universal inputs and 3 CAN inputs). In this example, CAN 1 input was set up for engine coolant temperature. Examples of other stimuli via the CAN or universal inputs include the intercooler temperature and engine oil temperature.

3.2 Hydraulic Fan Control with Reversing (continued)

When in Hydraulic Fan Control mode, the Fan Control Values table shows up on the Dashboard tab (Fig. 13). This shows the fault status of the controller, the state of the controller, and a timer when the state will change if reversing is used.

When setting up the ignition switch and minimum RPM, the following table of fault status and states of the coils should be considered (Fig. 14). The coil operation when in fault status is intended to minimize the load on the engine. When using an inverse-acting valve, the current draw may drain the engine battery and must be taken into consideration.

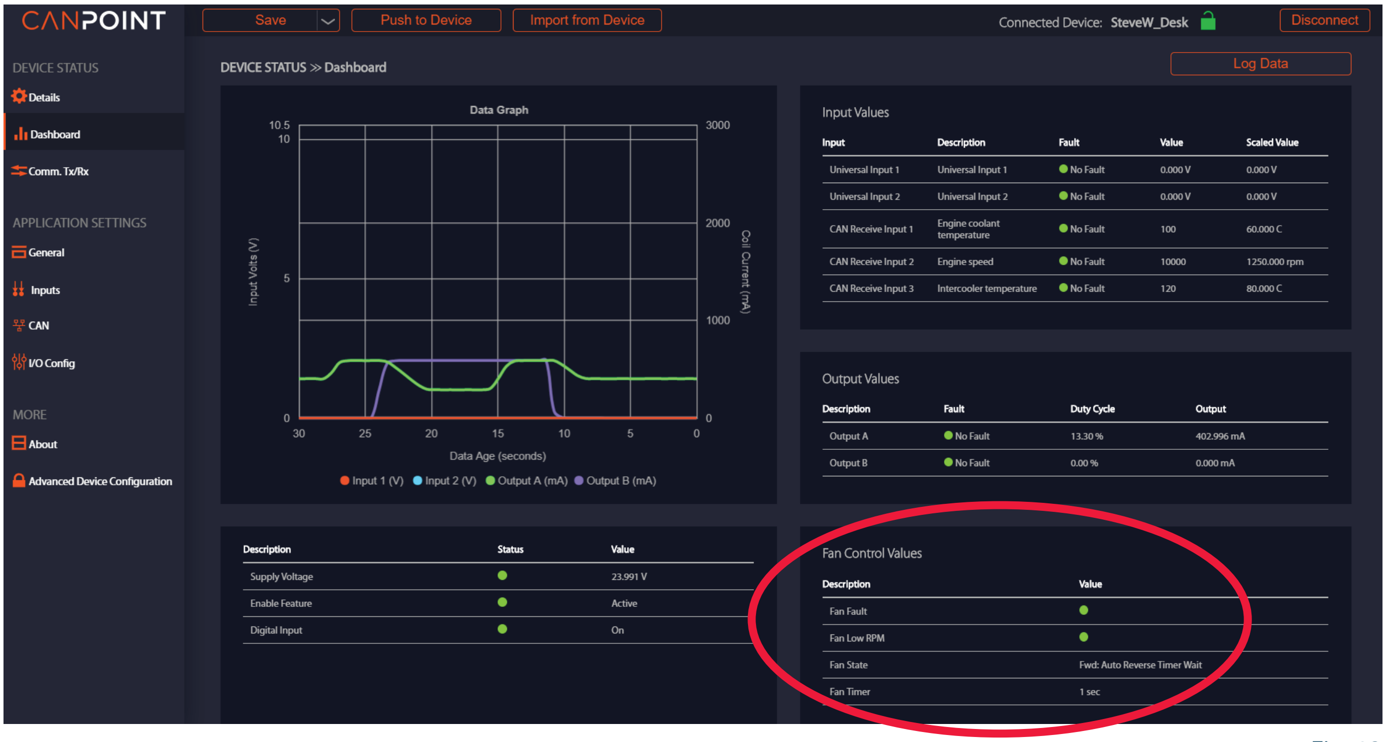


Fig. 13

Ignition Switch	RPM	Coil 1	Coil 2	Fault Status	LED
Switch made	OK	Normal operation	Normal operation	Normal operation	Green
Switch made	Low	Minimum speed current	Hold	Fan fault Fan low Engine RPM fault	Flashes red
Switch not made	OK	Fault current setpoint	Hold	Fan fault	Flashes red
Switch not made	Low	Minimum speed current	Hold	Fan fault Fan low Engine RPM fault	Flashes red

Fig. 14

4. CAN Bus Set-Up

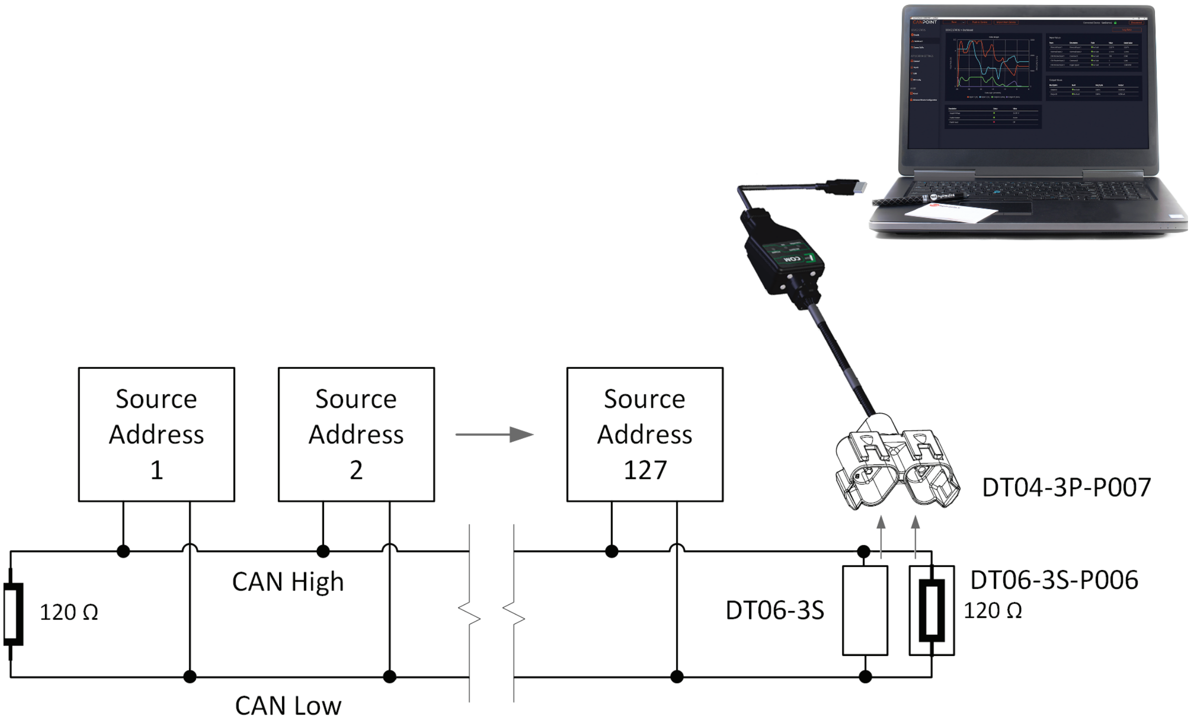
CAN bus inputs and transmits are set up through the CAN tab. The user should be familiar with SAE J1939 standard. This is not intended as a guide to CAN bus networks.

A CAN bus is a two-wire digital network. The figure below shows the topology of a CAN bus and Sun's USB-to-CAN adapter (Sun part number 991-728). The USB-to-CAN adapter comes with the Deutsch 3-way receptacle (DT04-3P-P007) and one 120-Ω resistor that is installed in a Deutsch plug (DT06-3s-P006). The CAN bus requires at least one 120-Ω terminating resistor connected between CAN-H and CAN-L in order to function properly. One 120-Ω resistor can be sufficient to connect an XMD to CANpoint via the USB to CAN adapter for short cable runs. However, best practice is to have two terminating 120-Ω resistors, and they are required for long cable runs.

Also, in order to have a complete CAN bus with multiple XMDs or other CAN capable devices, two 120-Ω resistors are required. Without a complete CAN bus, it isn't possible to use CAN messages as inputs to an XMD or for the XMD to transmit messages onto the bus for other devices to use. Each device on a CAN bus must have a unique Source Address.

The default Source Address on XMDs is 34 (decimal) or 22 (hexadecimal). CAN Transmit message 1 default PGN is ff81 (hex) and CAN Transmit message 2 default PGN is ff82. If multiple XMDs are on the same CAN bus, each will need to be assigned a unique Source Address. A Source Address between 1 and 127 (decimal) can be used before it is added to this existing CAN bus as long as it does not conflict with other devices on the CAN bus.

The Source Address and PGN (Parameter Group Number) must be set in CAN bus input message section for the CAN device that will be used for the CAN input. The CAN bus Transmit Message Source Address and PGN must be set on the other CAN devices on the bus to match what is being used on the XMD in order to receive CAN messages from the XMD. Consult SAE J1939 for other available PGNs if the defaults cannot be used.



4. CAN Bus Set-Up (continued)

CAN bus input messages must have the start bit, bit count, gain, and offset in addition to the source address set-up according the manufacturer's instruction for the CAN device being used for the input command. SAE J1939 is also a good source for this information. These values form what is sometimes called the SPN (Suspect Parameter Number) or parameter-specific number.

In order to decipher the CAN message correctly, the gain and offset need to be entered. Think of this as the simple equation for a line: y=mx+b where m is the gain and b is the offset. The CAN inputs can be named and engineering units applied on the CAN tab.

The XMD transmits its state in two CAN messages. The PGN for the first message defaults to ff81, and the second message defaults to ff82. The table shows the same information as the Comm. Tx/Rx tab.

Transmit Message	PGN	Description	Type	Start Bit	Length
CAN Transmit 1	ff81	Output A current	Scaler	0	16
CAN Transmit 1	ff81	Output B current	Scaler	16	16
CAN Transmit 1	ff81	Output A open	Boolean	32	1
CAN Transmit 1	ff81	Output A short	Boolean	33	1
CAN Transmit 1	ff81	Output B open	Boolean	34	1
CAN Transmit 1	ff81	Output B short	Boolean	35	1
CAN Transmit 1	ff81	Enabled	Boolean	36	1
CAN Transmit 1	ff81	Low voltage	Boolean	37	1
CAN Transmit 1	ff81	Universal 1 Out of range	Boolean	38	1
CAN Transmit 1	ff81	Universal 2 Out of range	Boolean	39	1
CAN Transmit 1	ff81	CAN message time out	Boolean	40	1
CAN Transmit 1	ff81	CAN value Out of range	Boolean	41	1
CAN Transmit 2	ff82	Universal input 1	Scaler	0	16
CAN Transmit 2	ff82	Universal input 2	Scaler	16	16
CAN Transmit 2	ff82	Supply voltage	Scaler	32	16

5. LED Operation

Power LED Operation		
Mode of Operation	**Status**	**Description**
Normal Operating mode, no faults		ON Green
Supply Voltage Below 9VDC		ON Red
Supply Voltage Above 32VDC		Blink / Red - 1 blink ON / pause OFF 500 ms

Comm / Fault LED Operation		
Mode of Operation	**Status**	**Description**
Normal Operating mode, OFF		OFF
Connected to mobile phone app / Configuration Mode		Blink / Green - 1 blink 125 ms ON/OFF 500 ms
Receiving CAN messages		Blink / Green – 2 blinks 125 ms ON / pause OFF 500 ms
CAN Message Timeout		Blink / Red – 2 blinks 125 ms ON/pause OFF 500 ms
Coil Short, ON RED		ON / Red
Coil Open		Blink / Red - 3 blinks 125 ms ON / pause OFF 500 ms
Command % out of range		Blink / Red - 1 blink ON / pause OFF 500 ms

6. Upgrades and other features

On the About tab, by selecting the "Download Sun Hydraulics CANpoint Updates" toggle, CANpoint will verify that the most current version of the software is installed on the computer with an internet connection.

On the Advanced Device Configuration tab, updates to XMD firmware can be made by downloading the file from SunHydraulics.com. Note: Later firmware versions of the XMD (2.19 and later) offer additional CAN messages. This tab is also where a password can be set for the XMD. Contact your nearest Sun Hydraulics facility for assistance with a forgotten password.

Sun Hydraulics Headquarters
Sarasota, Florida USA
+1 941 362 1200

Custom Fluidpower Pty Ltd
(A Sun Hydraulics Company)
Newcastle, Australia
+61 2 4953 5777
sales@custom.com.au

Sun Hydraulics Limited
Coventry, England
+44 2476 217 400
sales@sunuk.com

Sun Hydraulics Korea Corp.
Incheon, Korea
+82 3281 31350
sales@sunhydraulics.co.kr

Sun Hydraulik GmbH
Erkelenz, Germany
+49 2431 80910
sales@sunhydraulik.de

Sun Hydraulics China Co. Ltd.
Shanghai, P.R. China
+86 2162 375885
sunchinainfo@sunhydraulics.com

Sun Hydraulics Corp. (India)
Bangalore, India
+91 8028 456325
sunindiainfo@sunhydraulics.com

Sun Hydraulics Corp. (S.America)
Rosario, Argentina
+54 9 341 584 3075
ventas@sunhydraulics.com

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