AN101 – Connecting an Axiomatic Controller to a Danfoss PVEH, PVEA, PVES and PVEU Valve

Introduction

The 6 Input 5 Output Valve Controller (AX020510) is designed for extremely versatile control of up to five proportional outputs to directly drive solenoids or other loads. Its flexible circuit design gives users a wide range of configurable input and output types. Its sophisticated control algorithms allow users to program the controller for a wide range of applications without the need for custom software.

The controller has four Universal inputs that can be configured to measure analog voltage or current, frequency/PMW or digital signal and two Digital inputs that can be configured to measure frequency/PWM or digital signals. Measured input data can be sent to a SAE J1939 CAN Network or used to drive outputs directly or through the configurable control algorithms.

Half-bridge outputs with high side sourcing up to 2.5A produce the output signals. The outputs can be configured to drive proportional current (up to 2.5A), hotshot digital current, proportional voltage (up to power supply), proportional PWM or straight on/off digital loads. Any of the five proportional outputs can be configured to use any of the on-board inputs as either a control signal or an enable signal, as well as SAE J1939 CAN Network data.

The Windows-based Axiomatic Electronic Assistant (EA) is used to configure the controller via a USB-CAN device. The Axiomatic Electronic Assistant KIT, P/Ns: AX070502 or AX070506K, may be ordered from the Axiomatic website at: https://www.axiomatic.com.

Application Description

The Danfoss PVEA (PVEH, PVES, PVEU) control specification calls for a control signal range:

0.25 – 0.75 * Valve Supply Voltage (VDC)

Signal Voltage: Neutral	0.5 - VDC
Signal Voltage: A port	0.25 - VDC to 0.5 - VDC
Signal Voltage: B port	0.50 - VDC to 0.75 - VDC

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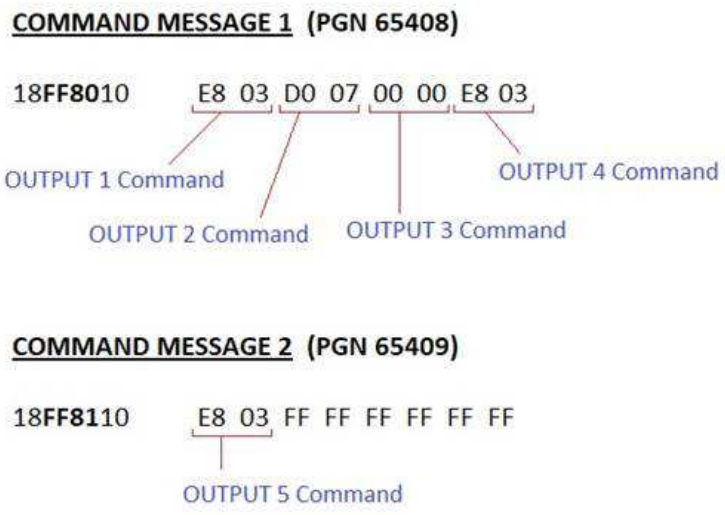
With the Axiomatic controller powered by the same supply voltage as the PVEA valve, its PWM Output Mode can be used to generate the PVEA control signal. The Axiomatic controller will accept command signals from the CAN network, and each of its five outputs will provide control for one PVEA valve.

CAN (J1939) Command Messages

The Axiomatic controller will expect five command signals sent on two CAN messages, one using PGN 65408, and the other using PGN 65409. These five signals will be used to control Outputs 1 – 5. All command signals are 2-bytes of data size and are organized within the CAN frames as shown below.



The command signals will have a range of 0 – 2000 bits, commanding the PWM output from 25 % to 75 % D.C. This allows for 1000 data points above/below the neutral position. A command of 1000 data bits will result in PWM output of 50 % (PVEA NEUTRAL position).

If any CAN signal is lost, the PWM output associated with that signal will default to 50 %.

CAN Command Signal	Axiomatic PWM Output	PVEA Control
0 bits	25.0%	PORT A - FULL
500 bits	37.5%	PORT A - HALF
1000 bits	50.0%	NEUTRAL
1500 bits	62.5%	PORT B - HALF
2000 bits	75.0%	PORT B - FULL

CAN RX Settings

CAN RX 1 – 5 function blocks are configured to receive the five control signals from the CAN bus. CAN RX 1–CAN RX 4 will accept the four signals in Command Message 1 on PGN 65408. CAN RX 5 will accept the last signal that is sent in Command Message 2 on PGN 65409.

CAN RX 1 setpoints are shown in the chart below. This configuration supports a 2-byte (16 bit) signal, range 0 – 2000 bits, at the 1st byte position of a CAN frame with PGN 65408.

Setpoint Group Name: CAN Receive 1

Setpoint Name	Setpoint Value	Comment
Receive Message Enabled	1	True
Receive PGN	0xFF80	Received PGN: 65408
Receive Message Timeout	250	ms
Address That Sends	0	False
Specific Address That Sends	-	Parameter not used - Receive from Source Address is Disabled
Receive Data Type	2	CAN signal continuous
Receive Data Width	16	-
Receive Data Index in Array	0	1st Byte Position
Receive Bit Index in Byte	0	1st Bit Position
Receive Data Resolution	1.0000000	-
Receive Data Offset	0.0000000	-
Receive Data Min (OFF Threshold)	0.0000000	-
Receive Data Max (ON Threshold)	2000.0000000	-

These same setpoints are repeated in CAN RX 2 – 4, with only the 'Receive Data Index in Array' setpoint being incremented, in order to point to the adjacent signals at the 3rd, 5th, and 7th byte positions of Command Message 1.

CAN RX 5 has the setpoint 'Receive PGN' modified to 65409, as it will accept the signal at the 1st byte position of Command Message 2.

Proportional Output Drive Settings

Proportional Output Drive 1 – 5 function blocks are configured to accept command signal by the CAN RX 1-5 function blocks and drive the PWM signal for control of the PVEA valve.

Proportional Output Drive 1 setpoints are shown in the chart below. This configuration sets the output in PWM Mode, an output signal range of 25% to 75% D.C., and links CAN RX 1 to the output as its Control Source.

Under normal conditions, an output will be controlled by its assigned Control Source. The 'Fault Detection', 'Output Fault Response', and 'Output in Fault Mode' setpoints determine how the output behaves when a fault condition is present. In this case, fault detection is enabled, and the 'Output Fault Response' is to apply the value stored in the 'Output in Fault Mode' setpoint. If there is a loss of the CAN signal, the output will be driven to 50% D.C.

Setpoint Group Name: Proportional Output Drive 1

Setpoint Name	Setpoint Value	Comment
Output Type	3	PWM Duty Cycle
Output At Minimum Command	25.0	%DC
Output At Maximum Command	75.0	%DC
Output At Override Command	50.0	%DC
Dither Frequency	-	Parameter not used with current Output Type selected
Dither Amplitude	-	Parameter not used with current Output Type selected
Ramp Up (Min to Max)	1000	ms
Ramp Down (Max to Mix)	1000	ms
PWM Output Frequency	25000	Hz
Hold Current	-	Parameter not used with current Output Type selected
Hotshot Current	-	Parameter not used with current Output Type selected
Hotshot Time	-	Parameter not used with current Output Type selected
Digital Response	-	Parameter not used with current Output Type selected
Digital Override State	-	Parameter not used with current Output Type selected
Digital Blink Rate	-	Parameter not used with current Output Type selected
Control Source	1	Received CAN Message
Control Number	1	Received CAN Message #1
Enable Source	0	Control Not Used
Enable Number	-	Parameter not used with current Enable Source selected
Enable Response	-	Parameter not used with current Enable Source selected
Override Source	0	Control Not Used
Override Number	-	Parameter not used with current Override Source selected
Override Response	-	Parameter not used with current Override Source selected
Fault Detection is Enabled	1	True
Output Fault Response	1	Apply Fault Value
Output in Fault Mode	50.0	%

The same setpoints are repeated for Proportional Output Drive 2 – 5, with only the setpoint ‘Control Source’ being incremented to accept control from CAN RX 2 – 5 function blocks.

CAN Signals

The CAN signal required for a given PWM output from the AX020510 can be determined using the expression below:

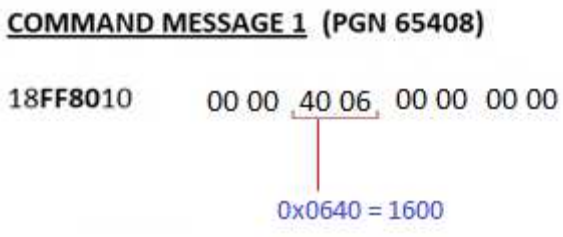
$$CAN\ Signal = \left(\frac{PWM - 25\%}{50\%}\right) \times 2000\ bits$$

For example, given a desired PWM signal of 65% on Proportional Output 2, the CAN signal is:

$$CAN\ Signal = \left(\frac{65\% - 25\%}{50\%}\right) \times 2000\ bits$$

$$CAN\ Signal = 1600\ bits$$

Therefore, send a signal with value of 1600 bits to CAN RX 2. The CAN Message 1 will be as below.



Application Variation

In a similar application, an Axiomatic controller could be used to control the position of the PVEA valve, while simultaneously regulating the hydraulic pressure of the system. To do this, one output could be configured as PWM mode for sending the PVEA control signal and positioning the PVEA valve. Another output could then be used in Proportional Current mode, to drive the coil of a Pressure Control Valve, regulating pressure in the hydraulic system.

Version	Date	Authors	Comments
1.00	September 10, 2019	Greg Laronde / Sue Thomas	Initial Release
1.01	September 11, 2019	Greg Laronde / Sue Thomas	Added the control Specification Chart
2.00	January 20, 2020	Greg Laronde / Sue Thomas	Made the application note less specific to the part number but more general. Added some applications in the field for configuration.
2.01	January 23, 2020	Greg Laronde / Sue Thomas	Updated the first two charts.
2.02	July 05, 2023	Greg Laronde / Sue Thomas / Kiril Mojsov	Legacy Updates & Marketing Review