Application Note - AN-114

Closed Loop Valve Control

NOTICE

This application note is provided for use as a general example and a guide. Divelbiss assumes no responsibility, liability or warranty regarding this application, its use, functionality or reliability to meet application needs. User assumes all responsibility to ensure all safety precautions are taken when using this application note. This application must not be used alone in applications which would be hazardous to personnel in the event of a failure. Precautions must be taken by the user to provide mechanical and/or electrical safeguards external to this application and controllers shown.

Application Description

This application illustrates how to control valve operation using Pulse Width Modulation (PWM) in closed loop configuration. Closed-loop identifies that there is **active feedback** to identify error and adjust the PWM to verify the valve has reached it's intended target (coil current).

With a given setpoint, the valve is controlled using a PID (Proportional, Integral, Derivative) algorithym. The valve is controlled based on it's actual coil current (maintaining a constant coil current ensures an accurate flow rate as temperature changes) and the PID ensures the setpoint (current) is reached and maintained. If the setpoint should change, the valve will smoothly adjust to the new parameter.

Equipment Used

Harsh Environment 4000 Series		
Controller Part #:		HEC-4100-E-R
Programming Software:		EZ LADDER Toolkit
Digital I/O:		On -Board
Application Filename:		AN114-HEC4X.dld
Programming Cable:		HEC-910 & Null Modem

This Application Note applies to any Divelbiss Controller that programs with EZ LADDER Toolkit and Pulse Width Modulation (PWM) Outputs with current feedback. To use other targets, generally, only a few program changes are required (typically I/O assignments).

Input / Output Description

PWM0: Pulse Width Modulation Channel 0. This channel is configured for 16 bit and the output signal is on the GPO0 pin.

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Program Variables

AN4	AN4 is the integer representation of the current feedback analog input for PWM0 (GPO0). For the HEC-4100, the analog range is 0-4095.
R_AN4	Analog Input 4 (AN4) converted to a real variable.
Slope:	This is a calculated real variable that represents the slope for the valve's current to flow diagram. See the notes in the actual program.
R_TempV	Real variable used as a temporary variable for calculations.
OffSet	This is a Real variable that is used for calculations. See the notes in the actual program.
PV	PV is the process variable (real variable) that is an input to the PID function.
Setpoint	This is a real variable that holds the current value of the desired setpoint (coil current) in Amps.
PWMout	The PWMout real variable drives the PWM function block and is the actual PWM control signal. It is calculated based on the PID function, inputs and setpoint.
Error	This real variable is an output of the PID function. It is the amount of error between the desired setpoint and the actual output (coil current).
Kp	Proportional PID input process variable (real variable).
Ki	Integeral PID input process variable (real variable). Generally, the larger Ki, the slower the output changes to setpoint changes.
Kd	Derivative PID input process variable (real variable). This is generally zero.
IO	This is the default I/O setting for the output when the PID function first starts.

Program Description

Rungs 6-9:	The current feedback analog input (AN4) is read and then converted to a real variable type for calculations. This value is then multiplied by the calculated Slope and then added to the calculated OffSet. These calculations end with the result of the PV (process variable).
Rungs 10-16	The PID function block with it's inputs and outputs calculates the actual PWMout which is used to drive the PWM0 output.
Rungs 16-17	The PWM0 is enabled with the PWM function block. The Duty Cycle is the PWMout calculated value.

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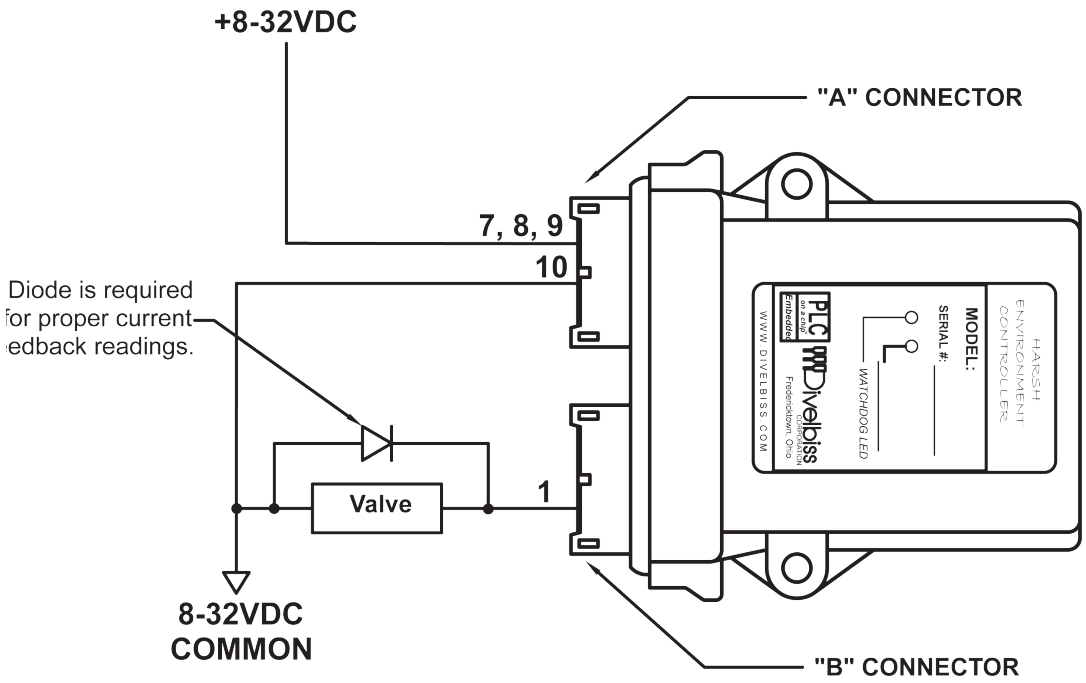
Connection Diagrams



Ladder Diagram