

DC Motor Control

NOTICE

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Application Description

This application controls a DC Motor using Pulse Width Modulation. The control is a closed loop system utilizing an analog input (potentiometer) to provide the set point, and a PID function to calculate and control the actual PWM output. It is based on RPM measurement for feedback. This example controls to RPM. If another unit of measure is required, other calculations would be required.

Based on actual system needs; the scan time, PID parameters and more will need to be configured and tuned for proper performance and operation.

Equipment Used

Harsh Environment 1000 Series	
Controller Part #:	HEC-1010-E-R
Programming Software:	EZ LADDER Toolkit
Digital I/O:	On -Board
Application Filename:	AN120-HEC1.dld
Programming Cable:	HEC-910 & Null Modem

Other controllers may be used providing that they support high speed counting (high speed counter inputs), analog inputs and Pulse Width Modulation (PWM) outputs.

Input / Output Description

- PWM1: Pulse Width Modulation Channel 1. This channel is configured for 16 bit and the output signal is on the GPO1 pin
- CNT 1: Counter Channel 1. This is where the sensor is connected to read the number of pulses (teeth)
- AN0: Analog Input 0. This analog input is connected to a potentiometer that supplies a set point of 0-5VDC (0-8000 RPM).

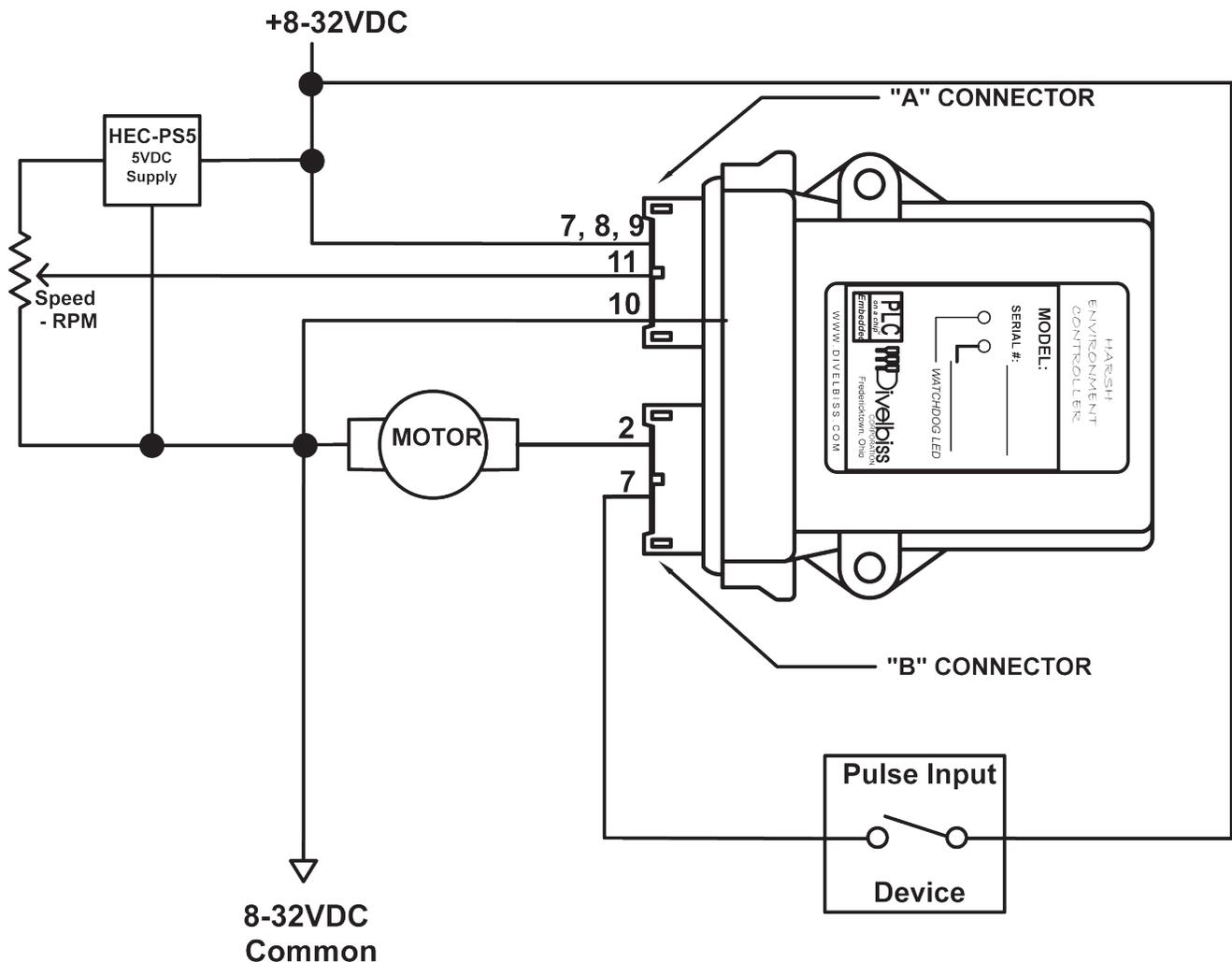
Program Variables

NumTeeth:	This variable is the actual number of teeth on the flywheel or gear. This value is defaulted to 60. To change this value, change the <i>Default Value</i> of the NumTeeth variable (using the Variable Edit Dialog).
R_NumTeeth:	This is a the converted value of the NumTeeth as a real variable type.
R_1200:	Real variable with a default of 1200. Used for calculations.
Multiplier:	Real variable that represents a multiplier needed to calculate speed based on the number of teeth and number of samples per minute.
CR1:	Boolean variable that is used to reset a high speed timer block causing it to restart timing.
TimVal1:	Integer variable used to hold the high speed timer output.
I_500:	Integer variable with a default of 500. Used for comparisons of the high speed timers.
PulseCnt:	Integer variable used to hold the actual number of teeth counted since the last counter reset.
Cnt_Store:	Real variable used to hold the actual number of teeth counted (converted from PulseCnt). This variable is only updated every 50mSec.
R_Speed:	Real variable representing the calculated speed.
Speed:	Integer (converted from Real) variable representing the speed (RPM).
Setpoint	This is a real variable that holds the current value of the desired set point (speed)
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 set point.
Error	This real variable is an output of the PID function. It is the amount of error between the desired set point and the actual output (coil current).
Kp	Proportional PID input process variable (real variable).
Ki	Integral PID input process variable (real variable). Generally, the larger Ki, the slower the output changes to set point 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.
I_Temp1	Temporary Integer variable used for calculations.
AN0	Integer variable that represents analog input 0 with a range of 0-1023.
R_1023	Real variable representing the maximum analog input value (1023.0).
Max_RPM	Real variable representing the maximum RPM speed of the DC motor.
R_Temp1	Temporary Real variable used for calculations.
R_Temp2	Temporary Real variable used for calculations.

Program Description

- Rungs 6-8: The number of teeth (integer) is converted to a real variable and then the Multiplier is calculated by dividing the number of samples per minute (1200) by the number of teeth. The Multiplier will be used to calculate the Speed.
- Rungs 10-12: The High Speed Timer function will begin timing (free runs) and when it reaches 500 (50mSec), on the rising edge, the PulseCnt is stored into Cnt_Store and CR1 is set true (for one scan)..
- Rungs 13-14: When CR1 is TRUE this High Speed Timer is reset to zero.
- Rungs 15-17: The speed is calculated by multiplying the stored counts in the last 50mSec time the multiplier calculated earlier.
- Rungs 19-25: The PID function block with it's inputs and outputs calculates the actual PWMout which is used to drive the PWM0 output (motor speed).
- Rungs 26-27: The PWM0 is enabled with the PWM function block. The Duty Cycle is the PWMout calculated value.
- Rungs 29-34: The analog input 0 is read and averaged then converted to a Real type variable. This result is divided by the maximum analog input reading (1023) and multiplied by the maximum DC motor speed in RPM (8000). The result is the set point fed into the PID function.

Connection Diagrams



Ladder Diagram

