PmodHB5™ Reference Component

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Overview

The PmodHB5 Reference Component controls the En and Dir pins of a PmodHB5 board to drive a DC motor. An input vector sets the duty factor of the signal driving the motor and a bit sets the rotation direction. Safe direction switching is implemented.

The vector setting the duty factor can be handled as binary or BCD, based on an internal constant value. The speed of the motor driven by the PmodHB5 is dependent on the duty factor of the driving signal and also on the mechanical load applied to the motor.

NOTE: As described in the *PmodHB5 Reference Manual*, the direction of the motor should not be reversed while the Enable pin is active. If the direction is reversed while the bridge is enabled, it is possible to create brief short circuits across the bridge as one leg will be turning on while the other leg is turning off. This could damage the bridge transistors.

The PmodHB5 Reference Component can also drive a PmodHB3, with no change.

Functional Description

Port Definitions

ck	input, clock signal (50MHz)
bitDirIn	input, the direction to rotate the motor
vecDfIn	input, sets duty factor for the Pulse Width Modulation (PWM) signal
bitEnOut	output, Enable pin for the PmodHB5
bitDirOut	output, Dir pin for the PmodHB5

Figure 1 ***PmodHB5 Reference Component***

Internal Constants

intPreDiv	the pre-division factor that defines the division factor used to build the internal clock (ckInt)
frequency(ckInt)	frequency(ckInt)/intPreDiv
strRadix	the string that defines the radix used for vecDfIn and internal counter; allowed values are Bcd for BCD (the whole PWM circuit works in BCD) and Hex for hexadecimal (the whole PWM circuit works in hexadecimal)
intSwDelay	number of ck periods to force bitEnOut low before and after changing bitDirOut

A PWM signal is generated for bitEnOut. The Duty Factor of bitEnOut is proportional to the value of the input vector vecDfIn.

The frequency of bitEnOut is frequency(ckInt)/256 if strRadix is Hex, and frequency(ckInt)/100 if strRadix is Bcd. The Duty Factor of bitEnOut is vecDfIn/256 if strRadix is Hex (resolution 1/256), and

vecDfIn/100 if strRadix is Bcd (resolution 1/100). The value of vecDfIn is encoded Hexadecimal or BCD based on the value of strRadix.

The output signal bitDirOut (and the motor rotation direction) is set according to the input signal bitDirIn. However, a change of bitDirIn does not reflect immediately in a change of bitDirOut. Instead, bitEnOut is first set low, then after a delay, bitDirOut is set to reflect the new value of bitDirIn, and after another delay, bitEnOut is enabled to resume the PWM signal.

This way, all the transistors composing the H-bridge of the PmodHB5 are turned off for a while before and after switching the active leg of the bridge.

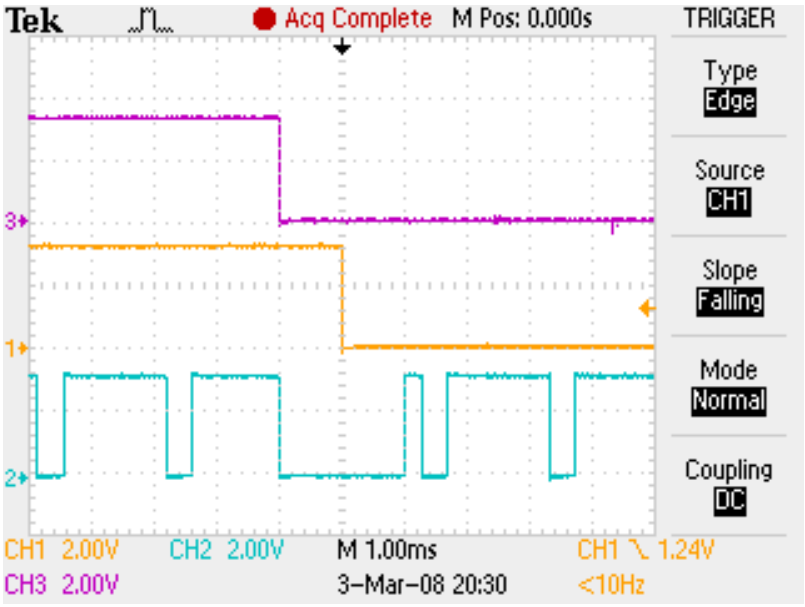

Figure 2 ***Safe Direction Switching***

Figure 2 illustrates this behavior. The upper signal (channel 3 of the scope) represents the signal bitDirIn. When this changes, bitEnOut, the lower signal (channel 2 of the scope), is forced low, breaking the regular PWM signal. After 1ms of delay (enough for the former active leg of the bridge to turn off), bitDirOut, the middle signal (channel 1 of the scope), changes to the value requested by butDirIn. Another 1ms of delay is inserted before bitEnOut resumes the regular PWM signal.

Figure 2 illustrates a severe condition for the motor. Starting from an 80% duty factor, which sets the motor close to the full speed in one direction, the direction is reversed with the same duty factor within 2ms. The time for which the bitEnOut signal is forced low is too short for the motor to stop, and when the 80% duty factor is resumed, the motor is still turning in the previous direction. Supplying the motor with reverse voltage will generate a severe mechanical shock. For a more sophisticated control system, the sequence should be: gradual speed decrease, direction change, and slow start. The experiment in Figure 2 demonstrates that even this severe condition is not dangerous for the PmodHB5.