PmodDHB1™ Reference Manual

Revision: February 4, 2013
Note: This document applies to REV A of the board.

Overview

The PmodDHB1 uses the Texas Instruments DRV8833 dual H-Bridge motor driver chip to drive two DC motors or one stepper motor.

Features include:

- Motor voltage can be driven up to 11.8V, with a recommended 10.8V maximum
- Two H-Bridge interfaces capable of 1.5A RMS (2A Peak)
- 2-channel quadrature encoder channels for Hall-effect sensors
- Two JST 6-pin connectors for direct connection to Digilent motor-gearboxes
- Logic input voltage range of 2.5V to 5V
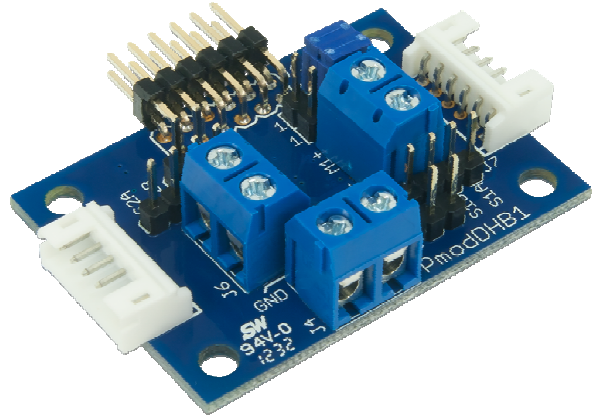
Functional Description

For a detailed description of the Texas Instruments DRV8833 please refer to the device data sheet available at TI.com.

The DHB1 is controlled through the Pmod connector J1. Logical levels on ENx and DIRx determine the Motor Direction and speed of the attached motors. The DHB1 uses a demultiplexer and pull-down resistors on the inputs to the DRV8833 H-Bridge pins to ensure that the H-Bridge works in fast decay mode.

The intended operation of the DHB1 uses the enable pin as the PWM input and the direction pin as a logic level selector to set the direction of the motor rotation. Table 1 lists the motor responses that result from various input combinations.

The DRV8833 chip provides overcurrent protection on the motor drive circuits. Each internal drive FET is independently monitored for an overcurrent condition and will be shut down internally to protect the chip. When an overcurrent condition is sensed the chip will shut down the FET with the fault and then set the NFAULT pin low signaling a fault condition on the chip. The remaining FETs will continue to operate as normal. When the fault condition is over, the chip will self-reset and return the NFAULT logic level to logic high. (See Table 2 for connector descriptions.)

There are two Schmitt trigger buffered inputs on connectors J2, J3, J7 and J8 that bring motor speed feedback signals to the controlling system board. The Digilent motor and gearbox have hall-effect sensors arranged in a quadrature encoder format. These buffers have 5V tolerant inputs, when operated at 3.3V.

DIR1	EN1	Result
0	0	Stop
0	1/PWM	Forward
1	0	Stop
1	1/PWM	Reverse
DIR2	**EN2**	**Result**
0	0	Stop
0	1/PWM	Forward
1	0	Stop
1	1/PWM	Reverse

Table 1: *Motor Control*

The quadrature encoder signals are a pair of square waves whose frequency is proportional to motor rotation speed and with the pulses 90° out of phase. You can determine the motor speed with the frequency and motor rotation direction by the phase relationship between the two signals.

Connector J1 – H-Bridge Interfaces		
Pin	**Signal**	**Description**
1	EN1	Motor 1 Enable
2	DIR1	Motor 1 Direction
3	S1A	Motor 1 Sensor A Feedback
4	S1B	Motor 1 Sensor B Feedback
5	GND	Power Supply Ground
6	VCC	Power Supply (3.3V)
7	EN2	Motor 2 Enable
8	DIR2	Motor 2 Direction
9	S2A	Motor 2 Sensor A Feedback
10	S2B	Motor 2 Sensor B Feedback
11	GND	Power Supply Ground
12	VCC	Power Supply (3.3V)
Connector J2- M1 JST 6-Pin Motor Connector		
Connector J3- M1 JST 6-Pin Motor Connector		
Connector J4- VM		
1	VM	Motor Power
2	GND	Power Supply Ground
Connector J5- M1 Power		
1	M1+	Motor 1 Positive Supply
2	M1-	Motor 1 Negative Supply
Connector J6- M2 Power		
1	M2+	Motor 2 Positive Supply
2	M2-	Motor 2 Negative Supply
Connector J7- M1 Feedback		
1	SA1-IN	Sensor A From Motor 1
2	SB1-IN	Sensor B From Motor 1
3	GND	Power Supply Ground
4	VCC	Power Supply (3.3V)
Connector J8- M2 Feedback		
1	SA2-IN	Sensor A From Motor 2
2	SB2-IN	Sensor B From Motor 2
3	GND	Power Supply Ground
4	VCC	Power Supply (3.3V)
Connector J9- Fault		
1	NFAULT	Overcurrent Condition
2	GND	Power Supply Ground
Connector J10- Sleep		
1	NSLEEP	Puts device into sleep state
2	GND	Power Supply Ground

Table 2: *Connector Descriptions*

Jumper Settings

Jumpers JP1 and JP2 allow both h-bridge outputs to be run from the same enable and direction pins. This allows the two bridge outputs to be operated in parallel to drive a single motor with twice the current. Refer to Table 3 for available settings.

Jumper	Setting	Description
JP1	1	Motor 2 Uses EN1
	3	Motor 2 Uses EN2
JP2	1	Motor 2 Uses DIR1
	3	Motor 2 Uses DIR2

Table 3: Set Jumper Description

Pulse Width Modulation and Motor Speed Control

Operators can control motor speed by varying the input voltage to a circuit. However, you can only apply a logic high or logic low signal to the motor in a digital circuit. There are only two ways to control a dc motor digitally. Either use a variable resistance circuit to control the motor voltage, or pulse the power to the motor. Since variable resistance circuitry is expensive, complicated, and energy inefficient because of heat loss, Digilent recommends controlling motor speed through pulse width modulation (PWM).

Pulse width modulation is a digital method of transmitting an analog signal. Even though PWM is not a clean source of DC output voltage, it controls motors well.

Figures 1 through 3 illustrate a PWM system with an input frequency of 2KHz. You control the motor speed by adjusting the time each wave remains at peak output power. Figure 1 demonstrates a 10% "duty cycle," where the signal is logic high for only 1/10 of a wavelength. This 10% positive peak is equal to 10% of the total 3.3V input, or 0.33V. (See

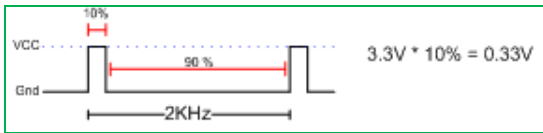Figure 1.) Figures 2 and 3 represent duty cycles of 50% and 75%.
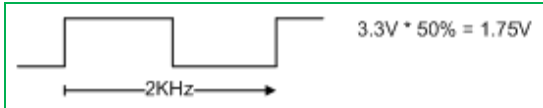

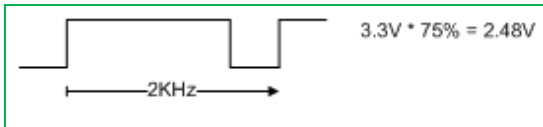**Figure 1.** *10% Duty Cycle*

Figure 2. *50% Duty Cycle*

Figure 3. *75% Duty Cycle*

An H-bridge is a voltage amplification and direction control circuit. Customers should use the H-bridge to format the signal to the appropriate motor voltage and polarity to spin the motor.

The changing magnetic forces that occur as you intermittently apply voltage drive the motor. Even when the voltage stops, momentum causes the motor to continue spinning. At a high enough frequency, this process of powering and coasting enables the motor to achieve a smooth rotation that can easily be controlled through digital logic.

PWM has two important effects on DC motors. PWM overcomes inertial resistance more easily at startup because short bursts of maximum voltage achieve a greater degree of torque than the equivalent DC voltage. PWM also generates a higher level of heat inside the motor. If customers use a pulsed motor for an extended time, they will need heat dissipation systems to prevent damage to the motor. Because of these effects, it is best to use PWM in high-torque infrequent-use applications such as airplane flap servos and robotics.

PWM circuits can also create radio frequency interference (RFI) that operators can minimize by locating motors near the controller and by using short wires. You may also need to filter line noise created by continually powering up the motor to prevent interference with the rest of the circuits. You can place small ceramic capacitors directly across the motor terminals and between the motor terminals and the motor case to filter the RFI emissions from the motor.

Note: For more information on the Pmod DHB1 see the product page at www.digilentinc.com.