

## **DRV8800/DRV8801 Design in Guide**

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### **ABSTRACT**

This document is provided as a supplement to the DRV8800/DRV8801 datasheet. It details the steps necessary to properly interface the device in most motion control applications powering a DC motor with conventional control signals such as PHASE and ENABLE.

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### **Contents**

|   |   |   |
|---|---|---|
| 1 | General Description .....   | 2 |
|   | 1.1 H-Bridge Motor Driver .....                                   | 2 |
|   | 1.2 Control Signals .....   | 2 |
|   | 1.3 Proportional to Current Voltage Output (VPROPI) .....         | 2 |
| 2 | Thermal Considerations .....                                      | 2 |
|   | 2.1 Junction-to-Ambient Thermal Impedance ( $\theta_{JA}$ ) ..... | 2 |
| 3 | Using VPROPI .....  | 3 |
|   | 3.1 Selecting the SENSE Resistor .....                            | 3 |
|   | 3.2 VPROPI Output .....   | 4 |
| 4 | Micro Processor Interface .....                                   | 8 |
|   | 4.1 Pulse-Width Modulating ENABLE .....                           | 9 |
|   | 4.2 Pulse-Width Modulating PHASE .....                            | 9 |

### **List of Figures**

|   |   |   |
|---|---|---|
| 1 | SENSE Resistor Connection .....                               | 3 |
| 2 | RC Network in Series With the VPROPI Output .....             | 4 |
| 3 | PHASE PWM .....   | 5 |
| 4 | Fast Decay: MODE1 = 0, MODE2 = 0 .....                        | 6 |
| 5 | Slow Decay: MODE1 = 1, MODE2 = X .....                        | 7 |
| 6 | VPROPI Limitations During Ground to Source Current Flow ..... | 8 |
| 7 | Micro Processor Interface .....                               | 9 |

## 1 General Description

### 1.1 H-Bridge Motor Driver

The DRV8800/DRV8801 consists of a single H Bridge capable of delivering up to 2.8-A peak current to a single DC motor load in both directions.

The H Bridge is protected against shorts to ground or power input by means of increased current detection.

The device is also protected against increased die temperature by implementing a thermal shutdown mechanism.

The SENSE pin can be used to set the maximum current so that the DC motor will drive at 100% duty cycle. This terminal can be connected to ground for maximum current (peak current limited by Over Current Protection circuitry).

### 1.2 Control Signals

The DRV8800/DRV8801 H Bridge offer PHASE and ENABLE control input lines which allow device users to control direction (with PHASE) and speed (by applying a PWM to the ENABLE pin).

The device also offers an improved means to control current through the motor winding recirculation. MODE 1 and MODE 2 input control signals grant three different degrees of slow/fast decay modes.

### 1.3 Proportional to Current Voltage Output (VPROPI)

The DRV8800/DRV8801 adds an important feature to motion control applications wanting to determine the current level flowing through the DC motor winding. An analog voltage output pin, called VPROPI for voltage proportional to current, supplies a signal which analog to digital converters and microcontroller applications can use to accurately determine how much current is flowing through the controlled DC motor.

## 2 Thermal Considerations

Although the DRV8800 and DRV8801 are rated at 2.8-A of current handling, the previous only holds true as long as the internal temperature does not exceeds 170°C. In order to operate at this rate, the following measures must be taken under consideration.

### 2.1 Junction-to-Ambient Thermal Impedance ( $\theta_{JA}$ )

The DRV8800RTY/DRV8801RTY device, cased in a QFN package, has a  $\theta_{JA}$  of 42°C/W. At any given time during the steady state portion of the cycle, two FETs are enabled: A high side sourcing FET and a low side sinking FET. Die temperature can then be computed by [Equation 1](#).

$$T_{die} = 42 \frac{^{\circ}\text{C}}{\text{W}} \cdot I_{winding}^2 \cdot RDS_{ON} \quad (1)$$

The DRV8800PWP/DRV8801PWP device, cased in a HTSSOP package, has a  $\theta_{JA}$  of 33°C/W. At any given time during the steady state portion of the cycle, two FETs are enabled: A high side sourcing FET and a low side sinking FET. Die temperature can then be computed by [Equation 2](#).

$$T_{die} = 33 \frac{^{\circ}\text{C}}{\text{W}} \cdot I_{winding}^2 \cdot RDS_{ON} \quad (2)$$

### 3 Using VPROPI

The analog output VPROPI offers SENSE current information as an analog voltage proportional to said current. Said feature is only available when a resistor has been placed between the SENSE pin and ground, and a voltage is being drawn across said resistor. The following sections detail the equations required to properly select this resistor and extract the information from the VPROPI output.

#### 3.1 Selecting the SENSE Resistor

A SENSE resistor must be connected between the SENSE pin and ground as shown in Figure 1.

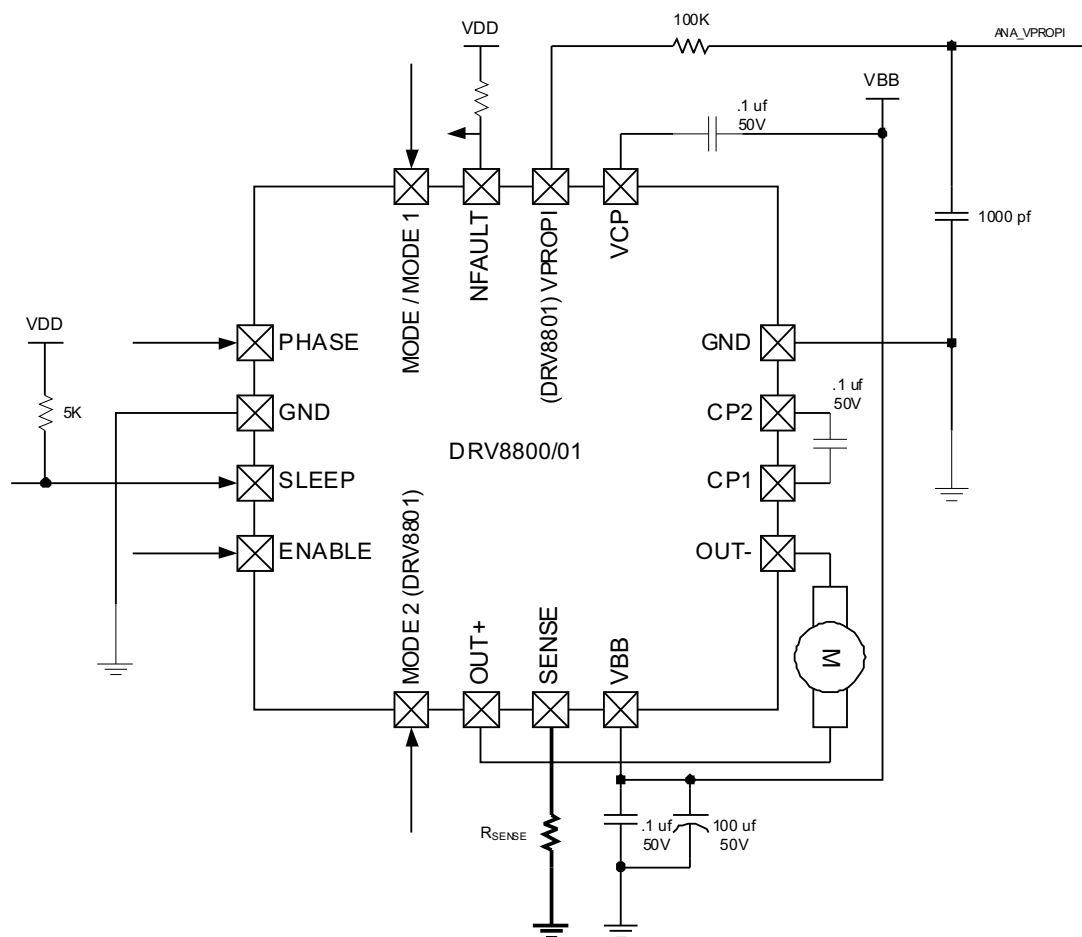


Figure 1. SENSE Resistor Connection

A lack of a resistor (i.e. a direct connection to ground) yields a SENSE voltage equal to zero. In that case, maximum current is 2.8 A and VPROPI outputs 0 V.

A resistor connected as explained before, will yield a VPROPI output as detailed in the next section. The voltage across this resistor has to be smaller than 500 mV. Any voltage equal or larger to 500 mV will signal the device to shut down as trip current has been reached. In this case, device will enter recirculation as stipulated by the MODE input pin (for the DRV8800) or MODE 1 and MODE 2 input pins (for the DRV8801).

Equation 3 shows the value of the resistor to a particular current setting.

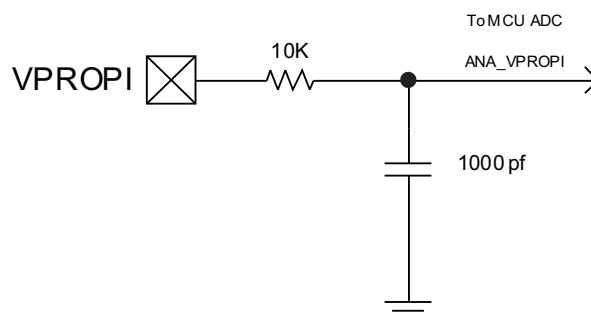
$$R_{sense} = \frac{500mV}{I_{trip}} \quad (3)$$

### 3.2 VPROPI Output

The analog output VPROPI varies proportionally with the SENSE voltage according to [Equation 4](#).

$$V_{PROPI} = 5 \cdot |V_{SENSE}| \quad (4)$$

An RC network in series with the VPROPI output is recommended, if this voltage is to be sampled by an analog to digital converter.



**Figure 2. RC Network in Series With the VPROPI Output**

It is imperative to realize that VPROPI will decrease to 0 V while the H Bridge enters slow decay recirculation.

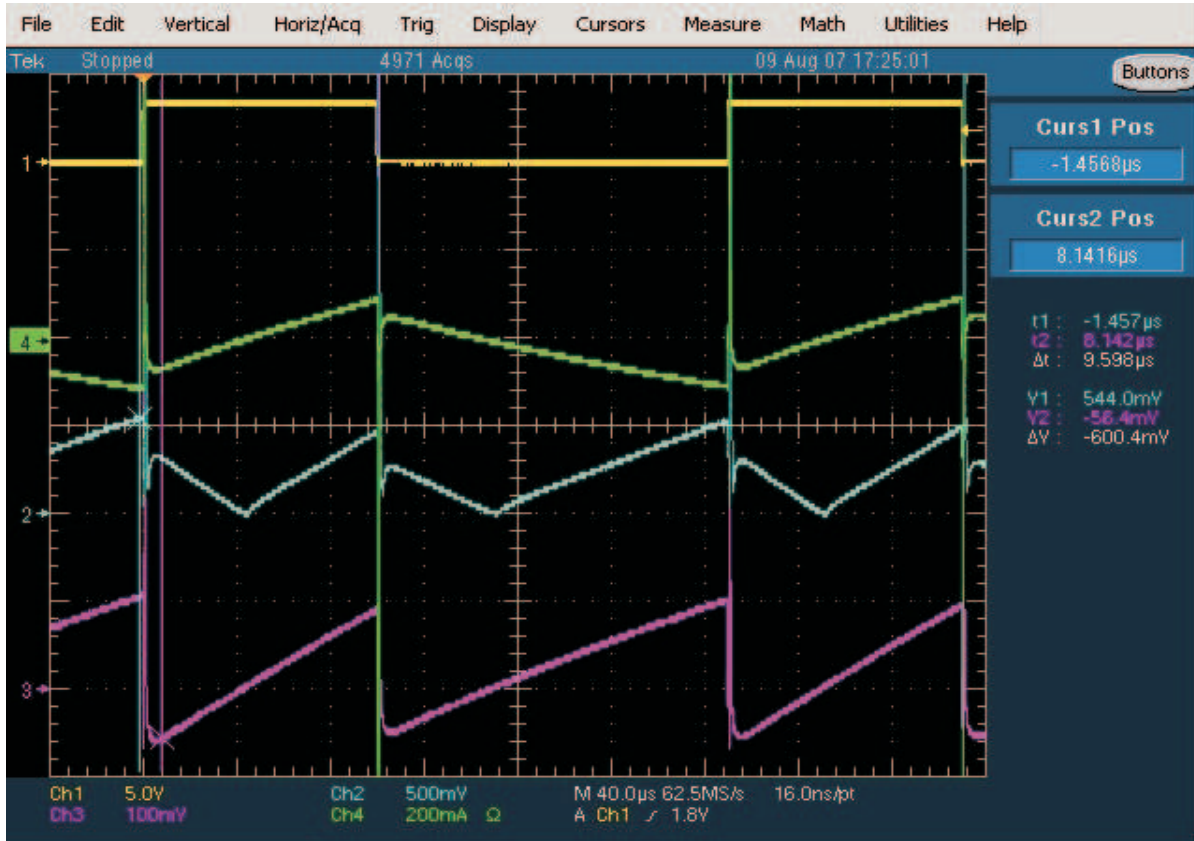


Figure 3. PHASE PWM

Channel 1 is PHASE pin.

Channel 2 is VPROPI analog output.

Channel 3 is SENSE pin.

Channel 4 is winding current.

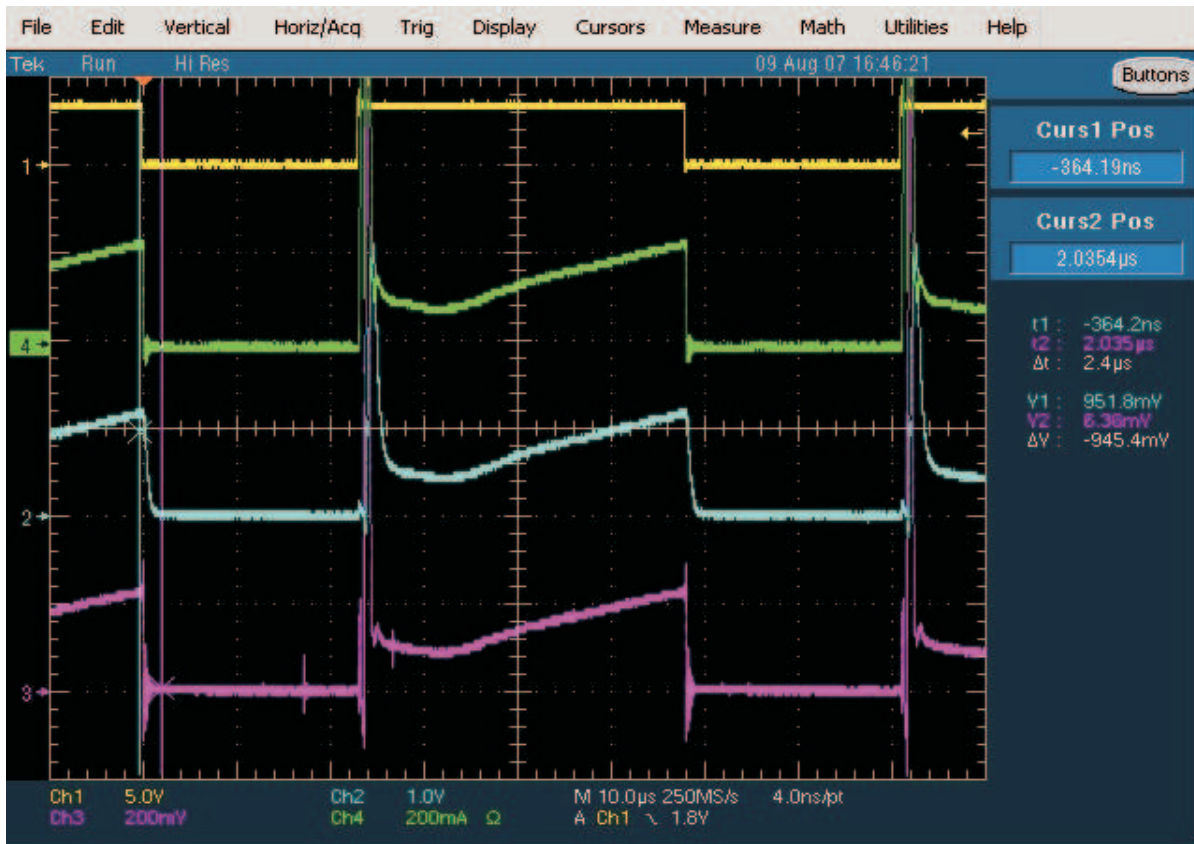


Figure 4. Fast Decay: MODE1 = 0, MODE2 = 0

Channel 1 is PHASE pin.

Channel 2 is VPROPI analog output.

Channel 3 is SENSE pin.

Channel 4 is winding current.

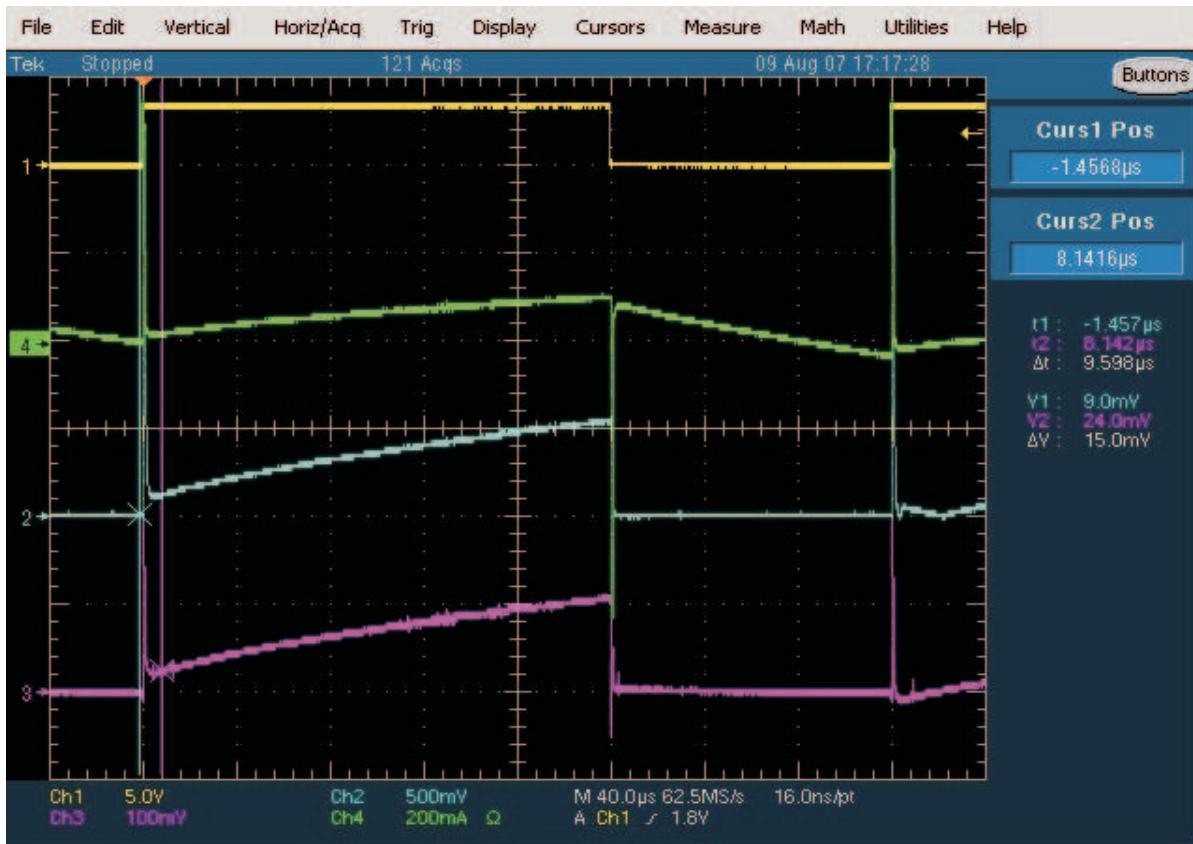


Figure 5. Slow Decay: MODE1 = 1, MODE2 = X

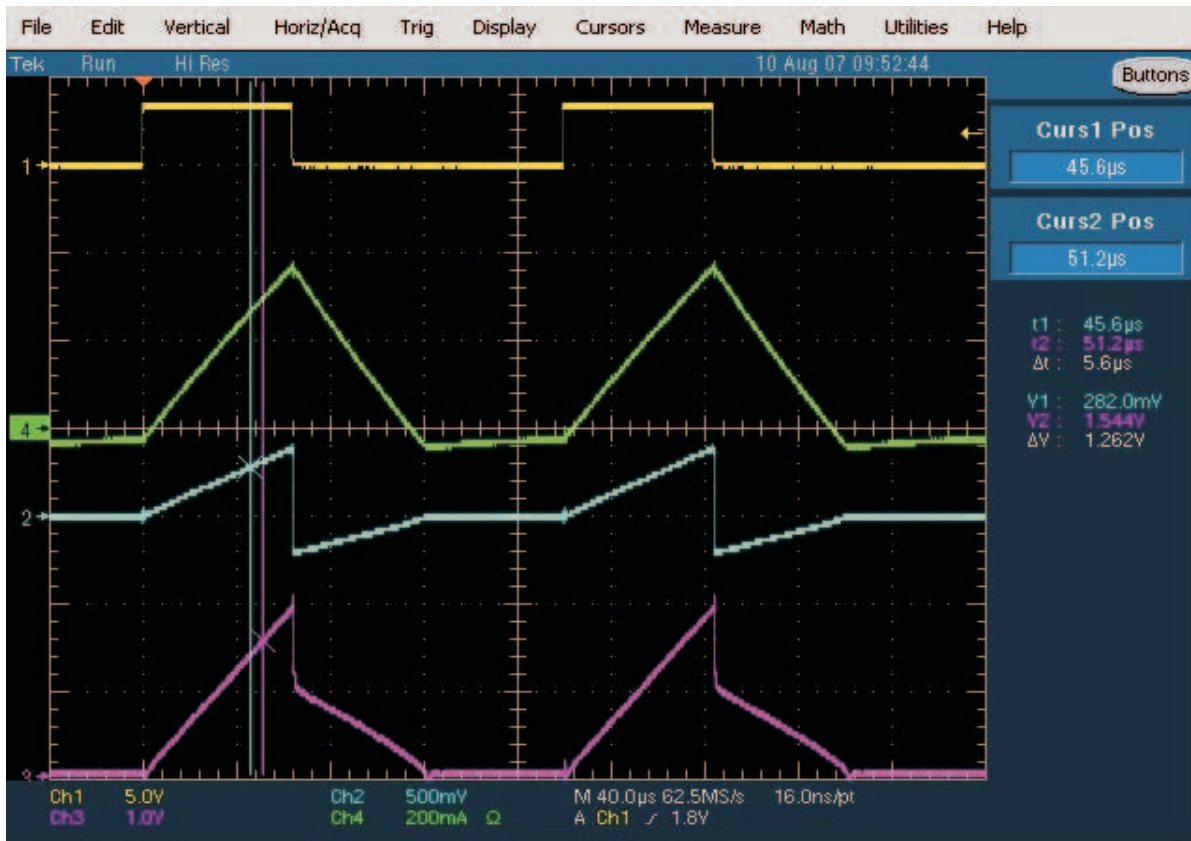
Channel 1 is PHASE pin.

Channel 2 is VPROPI analog output.

Channel 3 is SENSE pin.

Channel 4 is winding current.

VPROPI analog output will not offer winding current information while on slow decay mode (MODE1 = 1). In slow decay mode, the lower transistors (MODE2 = 0) or the upper transistors (MODE2 = 1) are enabled. Winding current flow decays through this transistor pair and not through the SENSE resistor. VSENSE = 0 V and VPROPI is 0 V as well.



**Figure 6. VPROPI Limitations During Ground to Source Current Flow**

Channel 1 is ENABLE pin.

Channel 2 is SENSE pin.

Channel 3 is VPROPI analog output.

Channel 4 is winding current.

VPROPI analog output is meaningful during current flow with positive polarity (from VBB to SENSE). However, whenever the winding current flows from GND, through the SENSE resistor and into the source (VBB), while it decays, current magnitudes larger than a threshold proportional to the SENSE resistor will trigger parasitic current flow. As a result, winding current is a function of current flowing through the SENSE resistor and current flowing through the parasitic path.

#### 4 Micro Processor Interface

The DRV8800/DRV8801 can be easily controlled with most microcontrollers. At the most, seven I/O pins are required. All of the digital control signals can be handled with conventional GPIO pins configured as outputs. ENABLE and PHASE control signals can be pulse-width modulated by using timers, allowing for proportional direction and speed control.



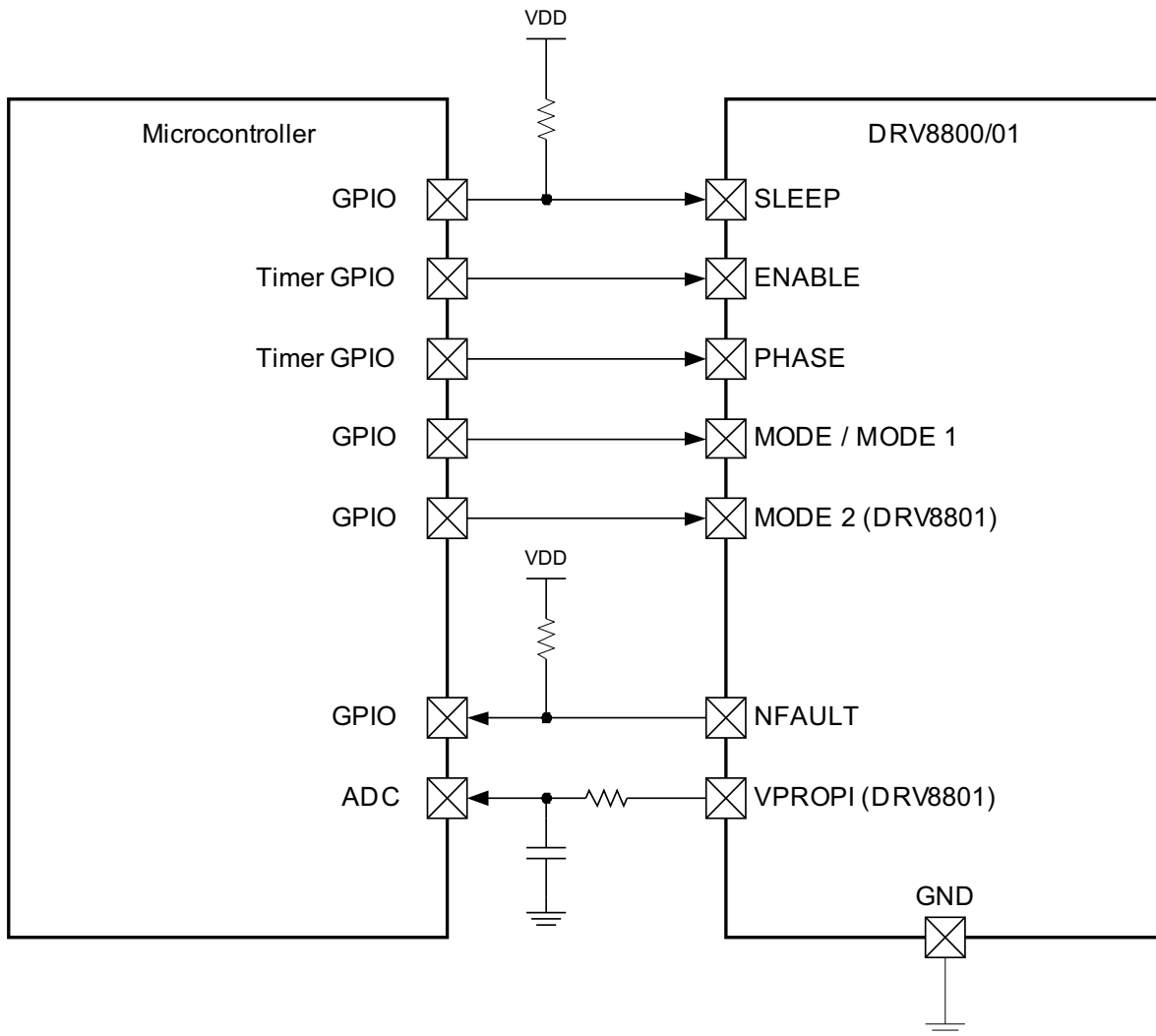


Figure 7. Micro Processor Interface

#### 4.1 Pulse-Width Modulating ENABLE

The most common H-Bridge direction/speed control scheme is to use a conventional GPIO output for the PHASE (selects direction) and pulse-width modulate ENABLE for speed control.

#### 4.2 Pulse-Width Modulating PHASE

Another technique widely used is to use a speed/direction control scheme where ENABLE is connected to a GPIO output and the PHASE is pulse-width modulated. In this case, both direction and speed are controlled with a single signal. ENABLE is only used to disable the motor and stop all current flow.

When pulse-width modulating PHASE, a 50% duty cycle will stop the motor. Duty cycles above 50% will have the motor moving on the clockwise direction with proportional control; 100% duty cycle represents full speed.

Duty cycles below 50% will have the motor rotating with a counter clockwise direction; 0% duty cycle represents full speed.

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