

CPG004_DRV88xx Evaluation Modules

This document is provided as a supplement to the DRV8802, DRV8812, DRV8813, DRV8814, DRV8824, DRV8825, DRV8841 and DRV8843 datasheets. It details the hardware implementation of the CPG004 DRV88xxEVM Customer Evaluation Module (EVM). On this document, DRV88xx will be used interchangeably to refer to any of the aforementioned devices.

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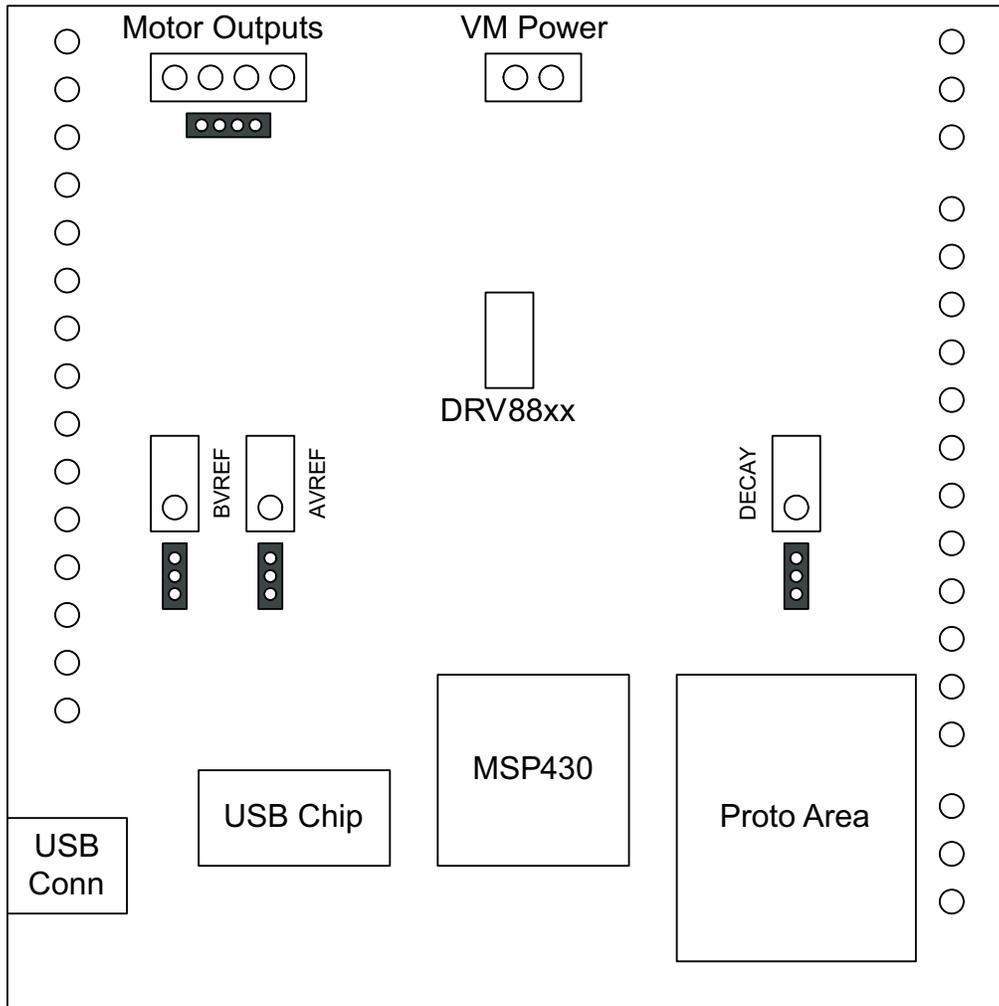
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1 Block Diagram



Where DRV88xx stands for one of DRV8802, DRV8812, DRV8813, DRV8814, DRV8824, DRV8825, DRV8841 or DRV8843.

1.1 Power Connectors

The DRV88xx Customer EVM offers access to VM (Motor Voltage) power rail via a terminal block (J1). A set of test clips in parallel with the terminal block allows for the monitoring of the input power rail.

User must apply VM according to datasheet recommended parameters.

NOTE: VDD for logic and microcontroller is derived from USB interface.

1.2 Test Stakes

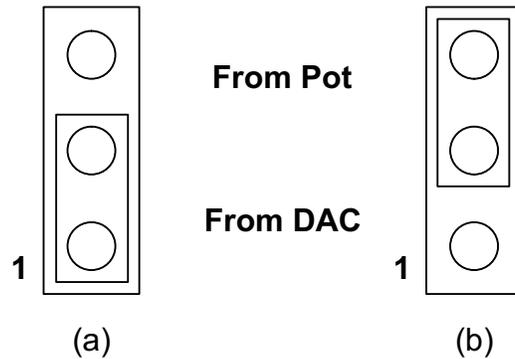
Every pin on the DRV88xx device has been brought out to a test stake. A label on the silkscreen identifies each signal.

For those pins that change functionality depending on device flavor, a table is provided with corresponding function name on its particular column.

1.3 Jumpers

There are only three jumpers the user must configure as detailed below. Default configuration assumes microcontroller resources are being utilized. As an alternative, a variable resistance is provided on the opposing jumper configuration.

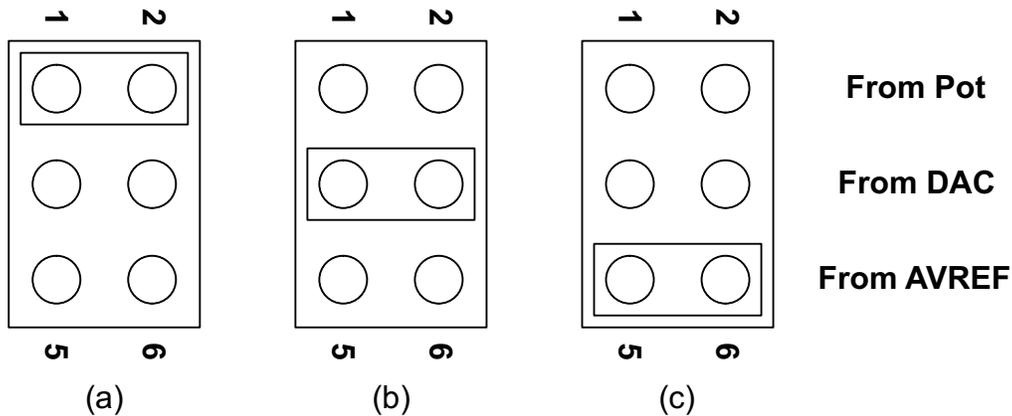
1.3.1 AVREF Select Jumper (JP2)



To configure the AVREF select jumper:
 (a) Use position JP2-1:2 to select the MSP430 DAC output (default).
 (b) Use position JP2-2:3 to select the respective variable resistance potentiometer. This jumper should not be left open as lack of reference voltage on the device will minimize current sourcing into the respective H Bridge, resulting in very poor motion or no motion at all.

Figure 1. AVREF Select Jumper Configuration

1.3.2 BVREF Select Jumper (JP1)



To configure the BVREF select jumper:
 (a) Use position JP1-1:2 to select the respective variable resistance potentiometer.
 (b) Use position JP1-2:3 to select the MSP430 DAC functionality.
 (c) Use position JP1-5:6 to select AVREF as reference voltage source. This jumper should not be left open as lack of a reference voltage on the device will minimize current sourcing into the respective H Bridge, resulting in very poor motion or no motion at all.

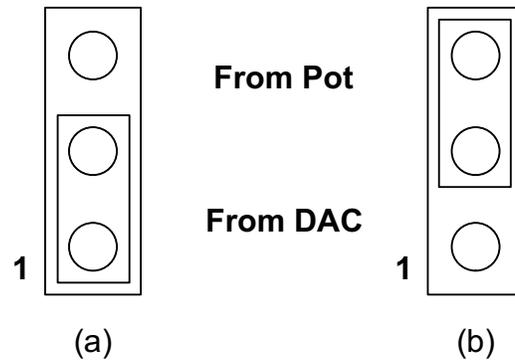
Figure 2. BVREF Select Jumper Configuration

1.3.2.1 BVREF Default Jumper Allocation

Table 1. BVREF Default Jumper Allocation on a Per Device Basis

DEVICE	BVREF JUMPER DEFAULT
DRV8802/12/13/14	JP1-3:4
DRV8824/25	JP1-5:6
DRV8841/43	JP1-3:4

1.3.3 DECAY Select Jumper (JP3)



To configure the DECAY select jumper:

- (a) Use position JP3-1:2 to select the MSP430 GPIO functionality (default).
- (b) Use position JP3-2:3 to select the respective variable resistance potentiometer. Allowing the jumper to not be placed, will result in the device operating under mixed decay mode.

Figure 3. DECAY Select Jumper Configuration

1.4 Motor Outputs

There are two ways of connecting the different motor styles (single bipolar stepper motor or two DC motors) into the CPG004_DRV88xx Evaluation Module: four pin header (J4) and four position terminal block (J3). Although feasible, we do not recommend the connection of any motor into the test clips as these are Kelvin connections and not rated for high current output.

2 Installing Drivers And Software

2.1 Installing the FTDI USB Driver

Instructions on how to install the FTDI USB driver on a Windows based computer are detailed in the “USB_Drivers_Install_Readme.pdf” file supplied with the CD inside the USB_Driver folder.

2.2 Installing the CPG004_DRV88xx Evaluation Board Windows Application Software

Copy the contents of the “WindowsApplication” folder provided within the CD, into your hard disk.

2.3 Running the Windows Application Software

To run the application, double click the CPG004_DRV88xxEVM_R0p2.exe application icon found on the same folder the application was extracted into.

3 The Windows Application

The CPG004_DRV88xxEVM Windows application is the software counterpart for the CPG004_DRV88xx EVM. It allows the PC computer to connect to the MSP430F1612 microcontroller through an USB interface chip. Once connection is established and commands are sent, microcontroller takes care of configuring control signals and administering certain levels of automation, such as microstepping generation for (DRV8812/13), STEP and DIR control (for DRV8824/25) or PWM output (for DRV8812/13/14/41/43).

The graphical user interface (GUI) has been designed to allow for all of the DRV88xx device’s functionality to be tested without having to intervene with the hardware, except for the proper configuration of jumpers, when needed.

The following pictures show the CPG004_DRV88xxEVM_R1p1.exe main screen. The application is divided into three tabs: one for each one of the three available device flavors. The menu contains items to configure and enable/disable the serial port.

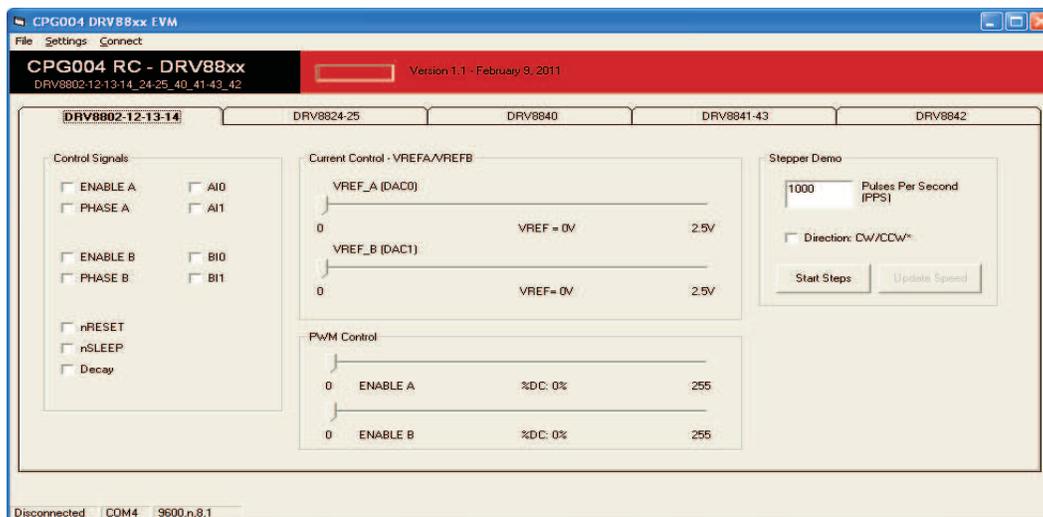


Figure 4. DRV8802-12-13-14 Tab

The DRV8802-12-13-14 tab contains all the control signals needed to control motor enablement (ENABLE A, ENABLE B), direction of rotation (PHASE A, PHASE B) and current control (Aix and Bix). Access to both DAC generating VREF analog voltages is achieved by moving sliders. Another set of sliders allow the control of PWM duty cycle on ENABLE x pins. This is intended for motion control.

A simple stepper demo allows hooking a bipolar stepper to the DRV8812 EVM and have its speed and direction controlled by an algorithm which modulates the VREF current in a high resolution microstepping style. This function is achieved by using both MSP430 DAC outputs and is only available if respective jumpers are set for dual DAC connection (as default).

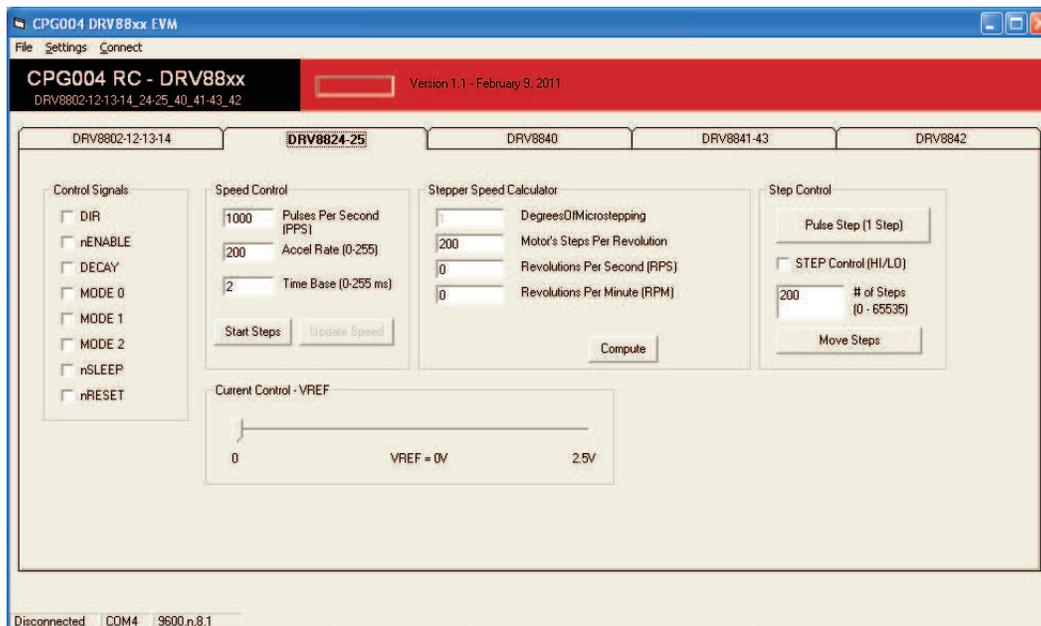


Figure 5. DRV8824-25 Tab

The DRV8824-25 tab contains all the necessary control signals to drive a bipolar stepper. Important aspects to control are enablement, direction of rotation, speed, number of steps, reference voltage (for maximum current) and degrees of microstepping.

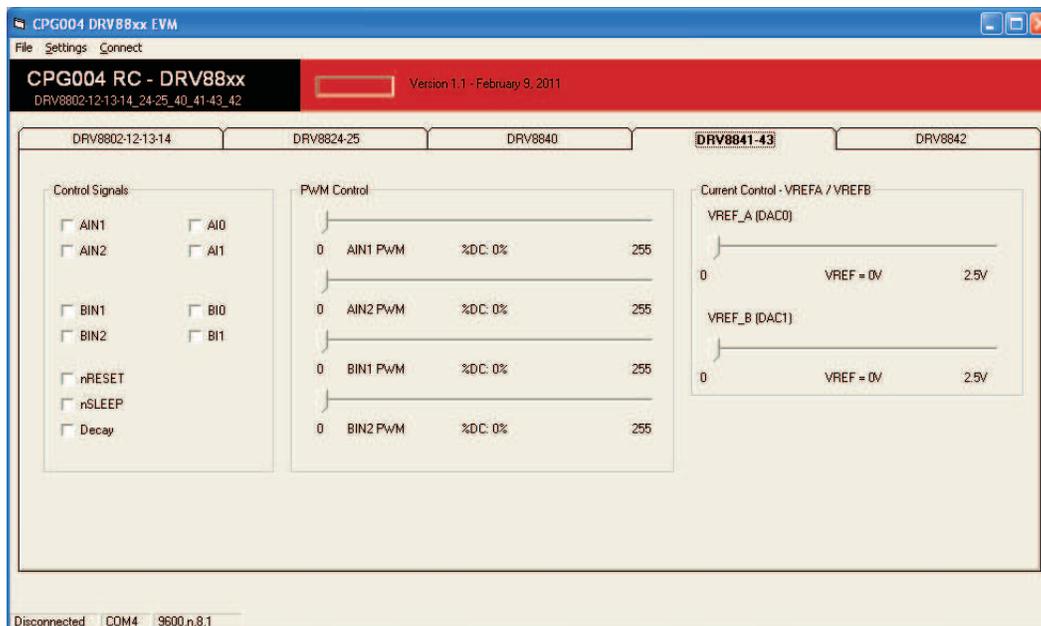


Figure 6. DRV8841-43 Tab

The DRV8841-43 tab is very similar to the DRV8802-12-13-14 tab, except correct naming conventions have been followed to showcase the AINx pins (instead of PHASE and ENABLE). In this tab, the four INx signals have a respective PWM slider in order to provide speed control per H Bridge on both directions per H Bridge.

3.1 The Menu

The menu at the top of the application offers a series of quick options for how the COM port is to behave.

File: Exit – Terminates the application

Settings: Port – Selects from COM1 to COM4. Default is COM4.

The serial port's actual port number defaults to what we have specified on the "USB_Drivers_Install_Readme.pdf". However, any port between COM 1 and COM 4 are equally usable.

Connect: Opens the serial port. When this menu item is pressed, its caption changes to "Disconnect".

Disconnect: Closes the serial port. When this menu item is pressed, its caption changes to "Connect".

After opening the application, the order of events should be:

1. Go to Settings → Port and choose the COM Port where the FTDI device has been configured to work. If the COM port is 4, then this step can be skipped, as application defaults to COM4.
2. Press Connect. If the port is available, the menu changes the "Connect" caption to "Disconnect". Press Disconnect to disable the serial communications.
3. <1><0><0> should return on the text box as an acknowledge. The text box also changes from red to green.
4. The application is ready for use.

3.2 DRV88xx GPIO Control Signals

Once the application is communicating with the interface board, the control signals can be actuated by checking or un-checking check boxes on the Signals frame. Each tab will have a different set of control signals as depending on the device being interface on. nSLEEP and nRESET control signals will be on all tabs.

Functionality of control signals is identical across the platform. A checked checkbox translates to a HI level on the respective control signal. Unchecked checkboxes translates to a LO level on the respective control signals.

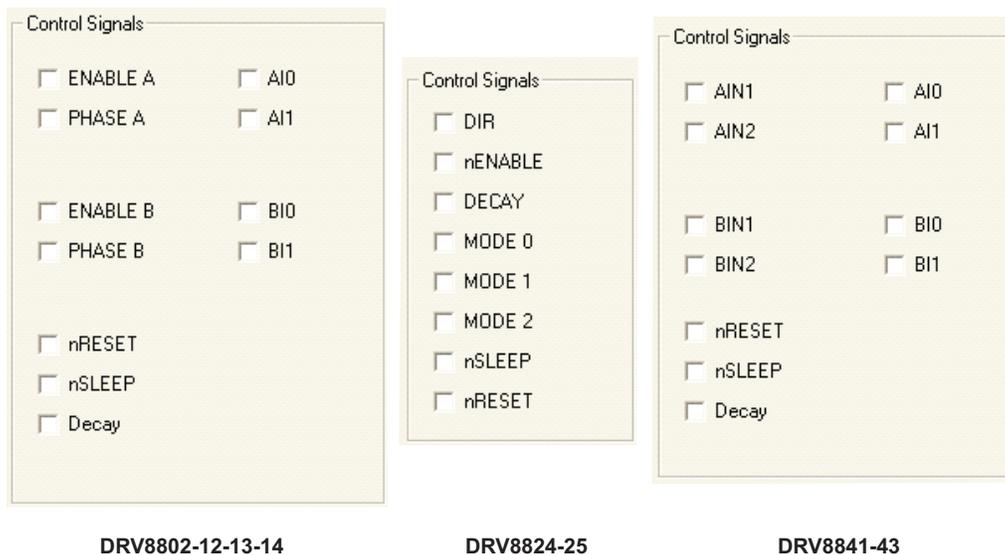


Figure 7. GPIO Control Signals

3.2.1 About DECAY

The DECAY pin is in reality a triple state input. The GPIO operates as HI and LO according to the checkbox. To have the DECAY pin floating, engaging mixed decay mode, simply remove the decay jumper JP3.

3.3 Updating DAC Output for Current Control (VREFA and VREFB)

If the DRV88xx has been configured to accept VREF analog voltages through the microcontroller DAC outputs (refer to Jumpers section), then the slider bar on the Current Control frame can be used to set the VREF voltage.

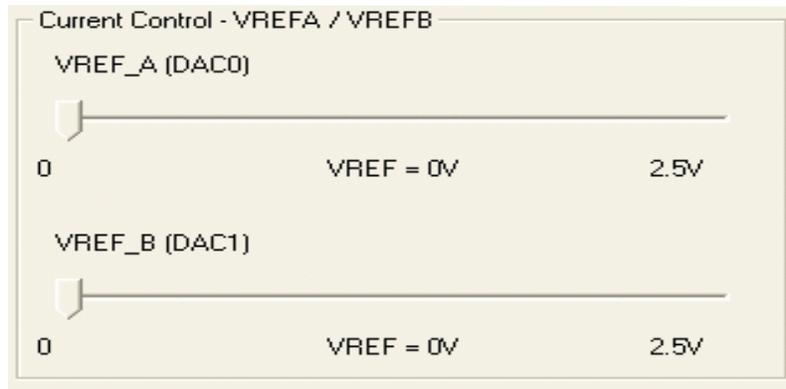


Figure 8. Current Control

The 12-bit DAC channels 0/1 are connected to the DRV88xx VREF analog inputs ABVREF and CDVREF. Changing the DAC digital value from 0 to 4095, changes the analog voltage at the respective VREF pin from 0 V to 2.5 V respectively, following the equation:

$$VREF = DAC_VALUE \cdot \frac{2.5 V}{4095} \tag{1}$$

Where:

VREF is the output voltage.

DAC_VALUE is a number from 0 to 4095.

Moving the sliders will update the “VREF = xV” caption below each respective slider with the result of the previous equation giving the user an idea of what analog voltage is being presented at the reference voltage input.

3.4 DC Motor Speed Control (PWM)

The DRV8802-14 can be utilized to control DC motors. For the purpose to control DC motor speed, a slider is provided which applies a PWM to the ENABLE line. The PWM slider consists of an 8-bit number so position from 0 to 255 are obtained. The MSP430 directly transforms this 8 bit number into the respective duty cycle. PWM frequency is around 31.25 kHz.

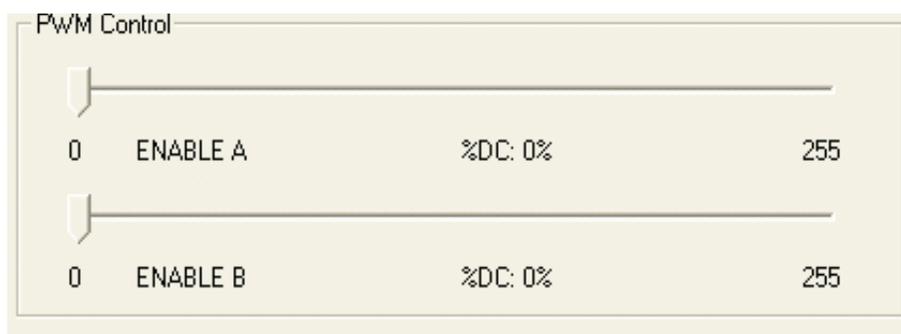


Figure 9. Duty Cycle Indicator

When the slider bar is moved across, the Duty Cycle indicator is updated accordingly. Resulting duty cycle is an integer number between 0 and 100 and it is computed according to the equation:

$$\%Duty\ Cycle = \frac{PWM}{255 \cdot 100} \tag{2}$$

The DRV8841-43 will offer the same ability to apply a PWM signal to each one of the INx pins.

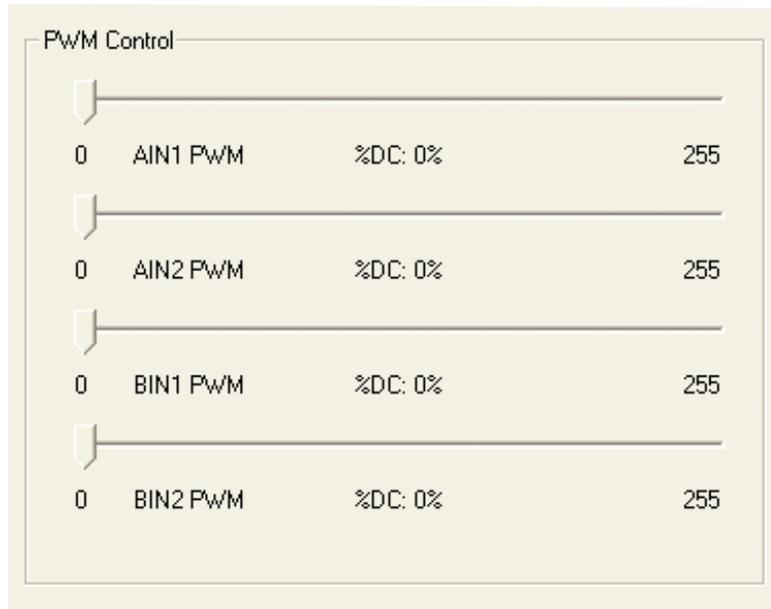


Figure 10. PWM Signal on INx Pins

3.5 Operating the Stepper Motor (DRV8824)

3.5.1 Turning the Stepper Motor

The Windows application, in conjunction with the MSP430F1612 microcontroller, utilizes a series of timers to coordinate the rate of steps sent to the device. Once all the control signals are configured accordingly, (ENABLE_n = LO, SLEEP_n = HI, RESET_n = HI; DIR, USM_x can be HI or LO depending on preferred mode of operation), the motor is ready to be turned.

The DRV88xx EVM allows for the possibility of coordinating step rates such that accelerating and decelerating profiles are achieved. Both acceleration and deceleration are controlled by the same parameters, acceleration rate and time base.

When the motor starts, it always starts at the slowed PPS speed (62 pulses per second). The controller will accelerate the motor in order to reach the PPS speed. Acceleration rate is an 8-bit number (0 to 255) that gets added to the current PPS speed and time base is an 8-bit number (0 to 255) that specifies how many milliseconds will elapse from one speed increase to the next. Once the specified PPS speed has been achieved, the acceleration stops.

When the motor stops, the inverse of the above description occurs.

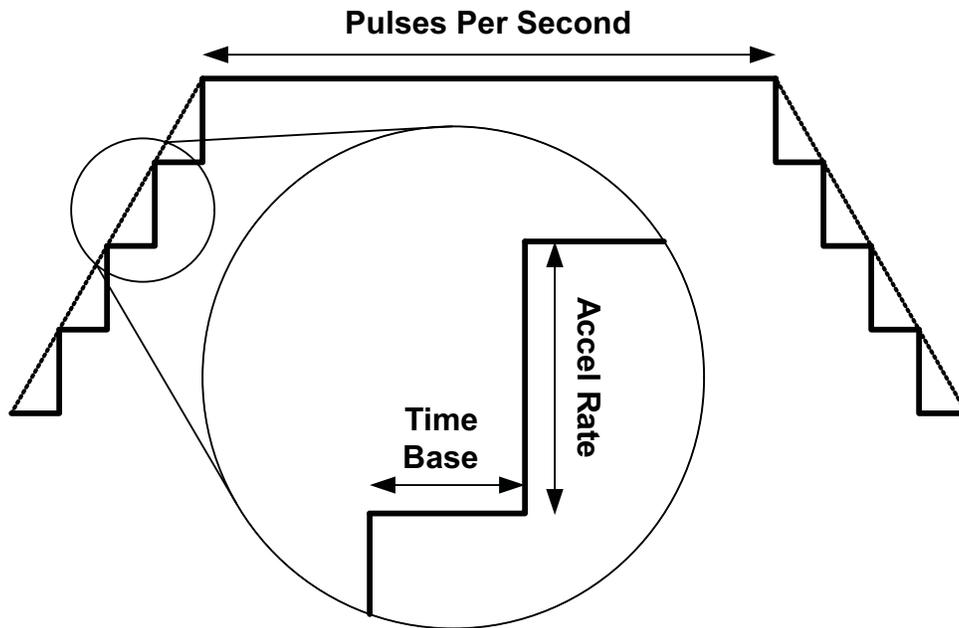


Figure 11. Turning the Stepper Motor

The Windows application frame to control speed, acceleration and deceleration, as well as motor start and stop, is shown in [Figure 12](#).

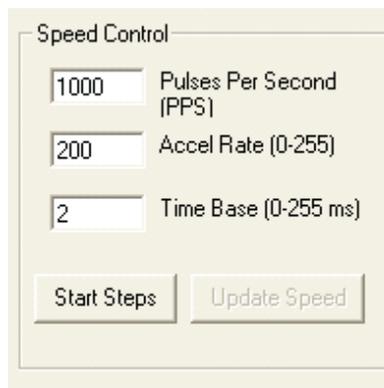


Figure 12. Speed Control

Pressing the “Start Steps” button, will start the timer and pulses will be generated at the rate specified by the decimal number at the PPS text box. Once the “Start Steps” button is pressed it becomes the “Stepping” button. Press the “Stepping” button to stop the stepper motion.

When the motor is stepping, the “Update Speed” button becomes enabled. Speed can be updated by modifying the PPS text box and then pressing the “Update Speed” button. The “Speed Button is disabled every time the motor is not turning because the stepping has been halted by pressing the “Stepping” button.

3.5.2 Step by Step Control

The step control frame has a series of tools to control the stepping of the motor on a predetermined number of steps fashion.

The “Pulse Step” button allows for a single step to be issued. Remember that a STEP takes place when STEP goes from LO to HI.

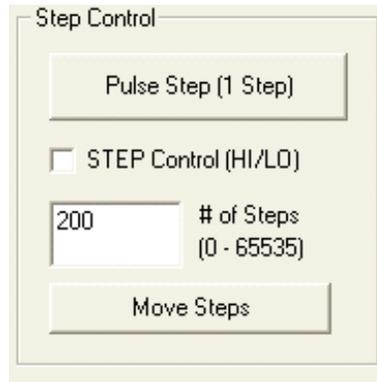


Figure 13. Step Control

To move the motor a number of steps and then stop, fill the # of Steps text box with a decimal number from 0 to 65535 and the motor will move that number of steps at the speed specified on the PPS text box. No acceleration or deceleration takes place under this function.

3.5.3 Stepper Speed Calculator

In order to easily translate steps per second to actual angular velocity, a simple calculator is provided. The calculator extracts step resolution information from the Mode x pins values and STEP frequency from the PPS text box. The user must then provide number of steps per resolution the motor has been manufactured to achieve. For example, a 1.8 degrees stepper motor would have 200 steps per revolution, and so on.

By pressing the Compute button, the calculator reports the revolutions per second and revolutions per minute parameters. For example, on the picture below, the stepping rate was set to 4000 steps per second. While microstepping with 4 degrees of microstepping, a motor with 200 steps per revolution should be moving at 5 revolutions per second or 300 revolutions per minute.

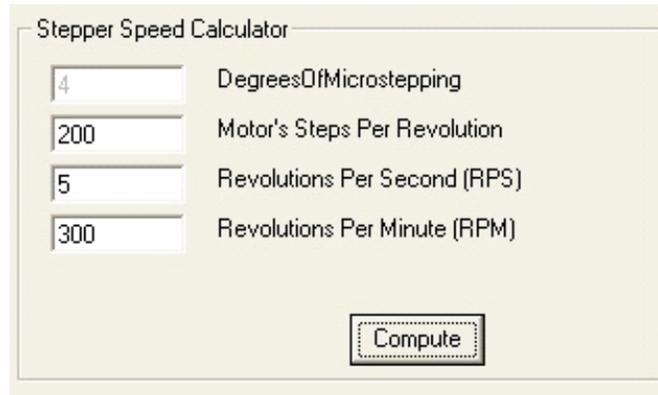
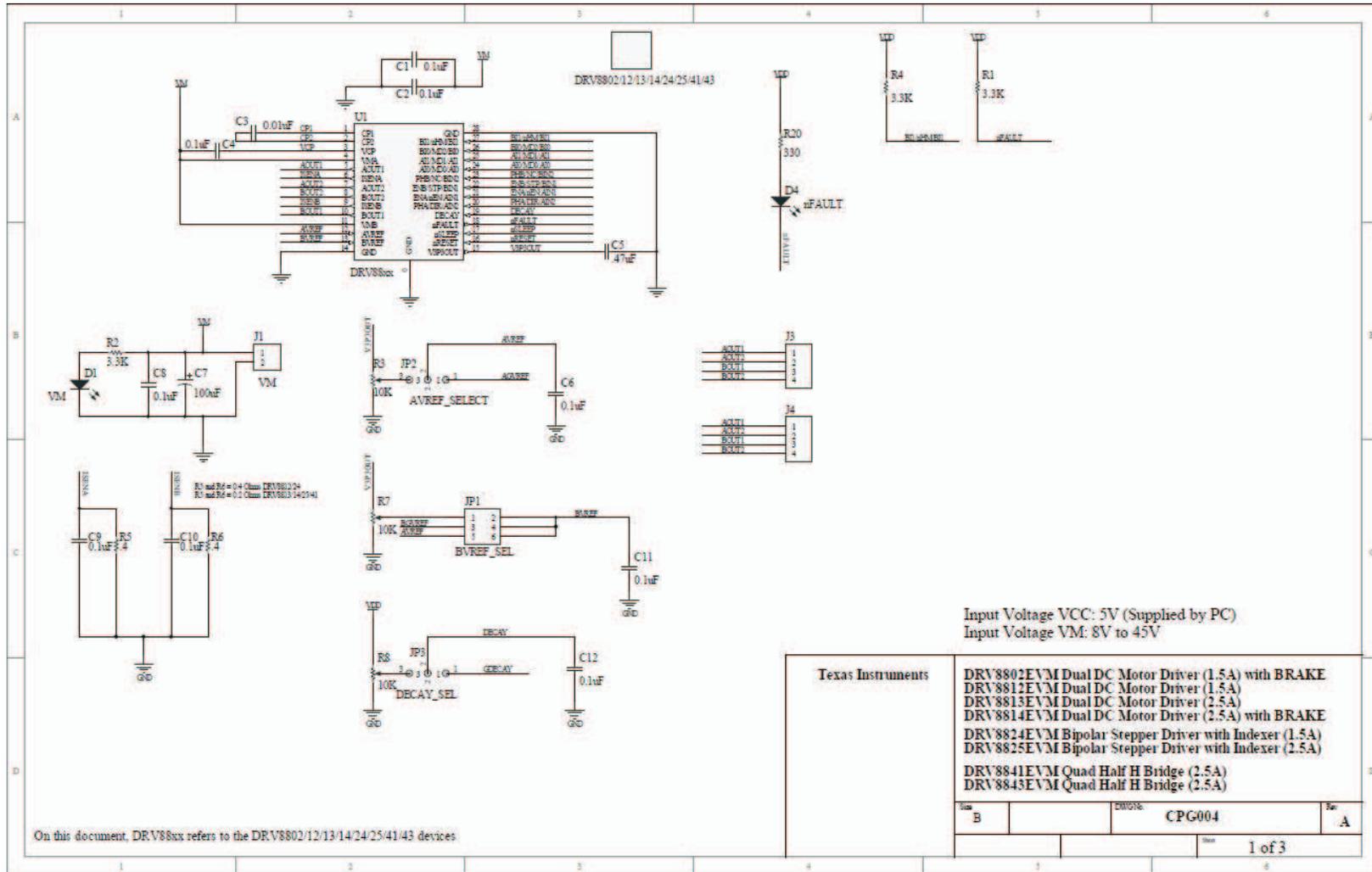
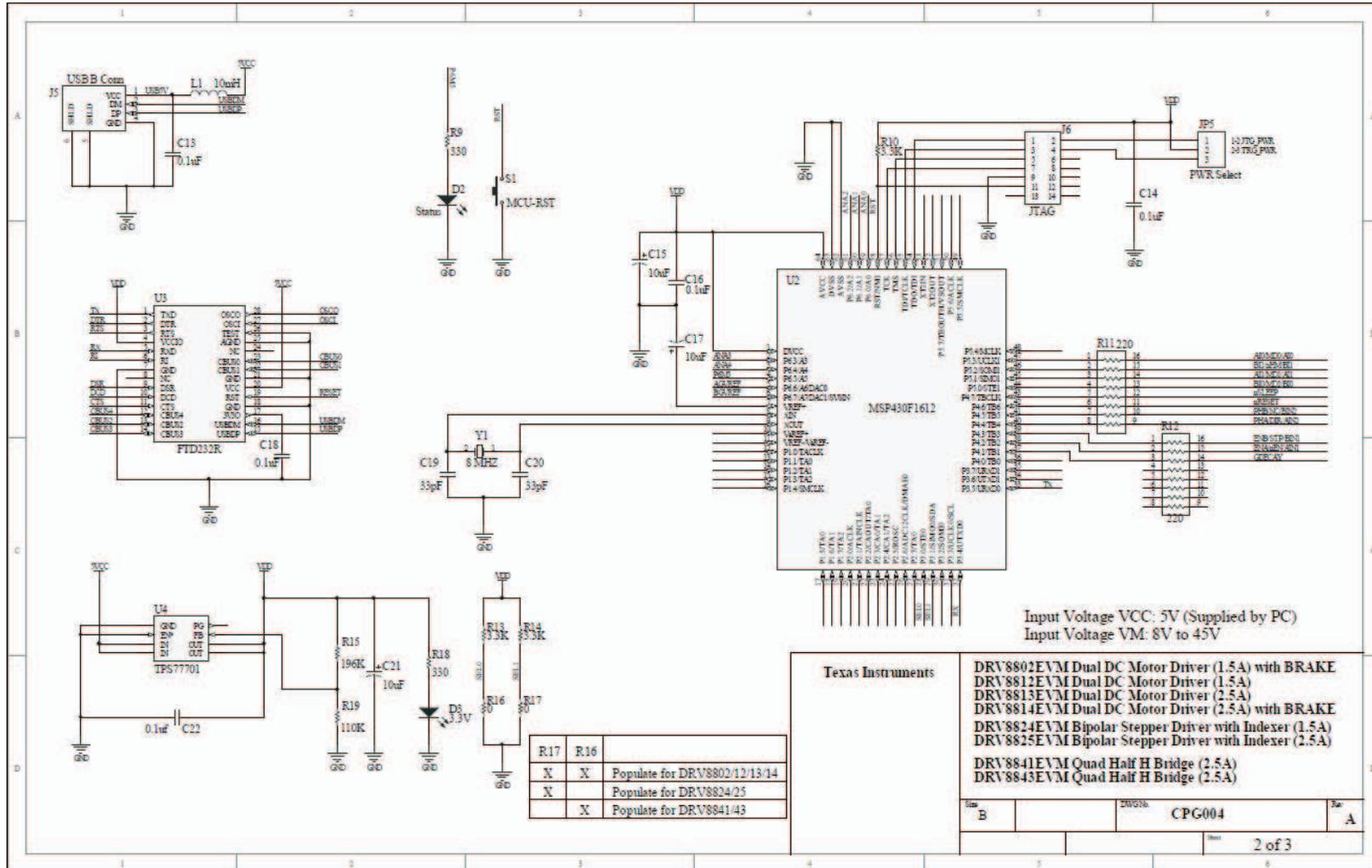


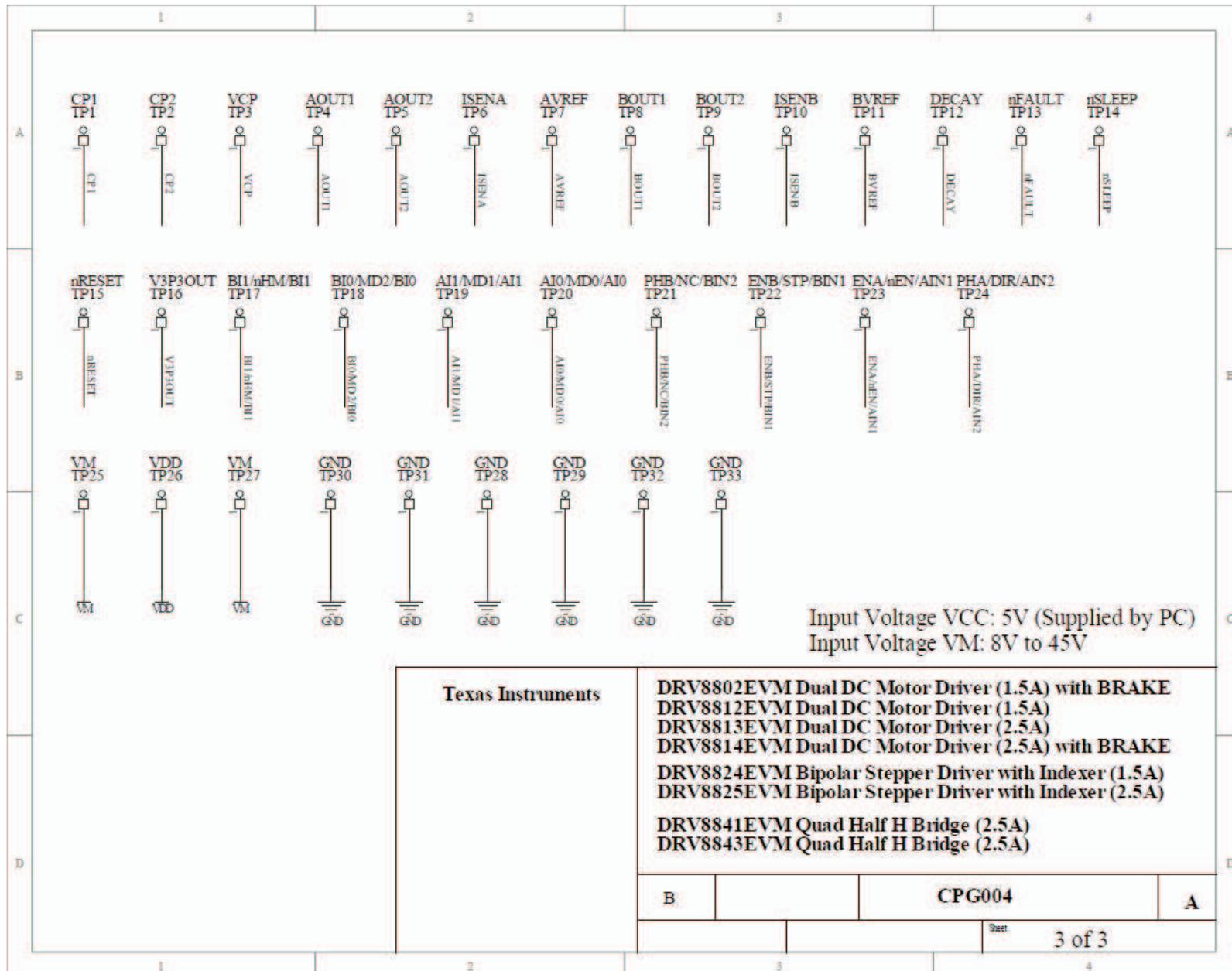
Figure 14. Stepper Speed Calculator

4 Schematics

See the following pages for schematics.







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