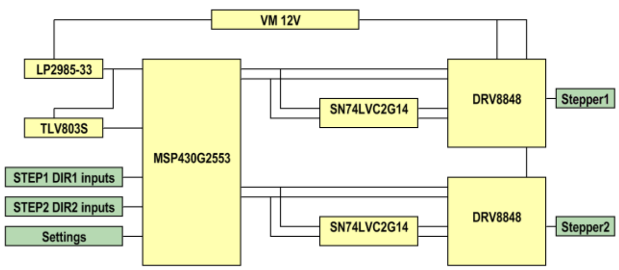
TIDA-00641 Dual High Resolution Micro-Stepping Driver

Design Overview

TIDA-00641 includes two DRV8848 and a MSP430G2553 as a high resolution micro-stepping driver module using PWM control method. Up to 1/256 micro-stepping can be achieved with smooth current regulation and ultra-low acoustic running noise.

Design Resources

TIDA-00641	Design Folder
DRV8848	Product Folder
MSP430G2553	Product Folder
SN74LVC2G14	Product Folder
LP2985-33	Product Folder
TLV803S	Product Folder

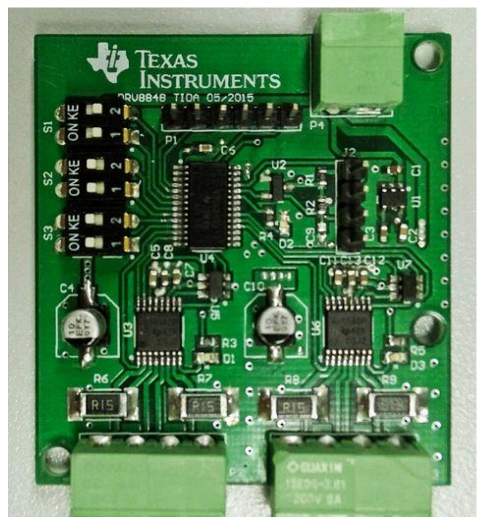


Design Features

- Smooth current and low acoustic noise
- Up to 1/256 micro-stepping level
- Selectable micro-stepping level
- Selectable current level
- Compact dual channel design
- Easy STEP/DIR interface
- Full protections

Featured Applications

- Security camera
- XY moving table
- 3D printer
- POS



1. Introduction

This reference design achieves a dual channel high resolution micro-stepping driver module using PWM current regulation method. Selectable micro-stepping level and current level is provided with the on-board switches. The PWM regulation scheme gives smooth phase current and ultra-low acoustic operation noise. Protections such as over current, over temperature, and short outputs are all provided along with the DRV8848 device.

2. Hardware Block Diagram

The following figures show the hardware block diagram of this design. Figure1 gives the block diagram and figure 2 shows the key control signals and the connection.

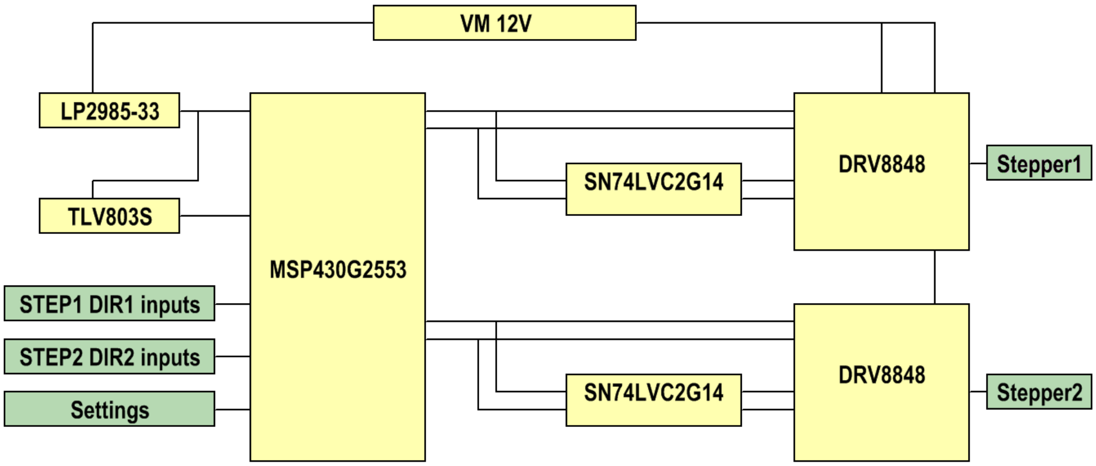


Figure 1. Hardware block diagram

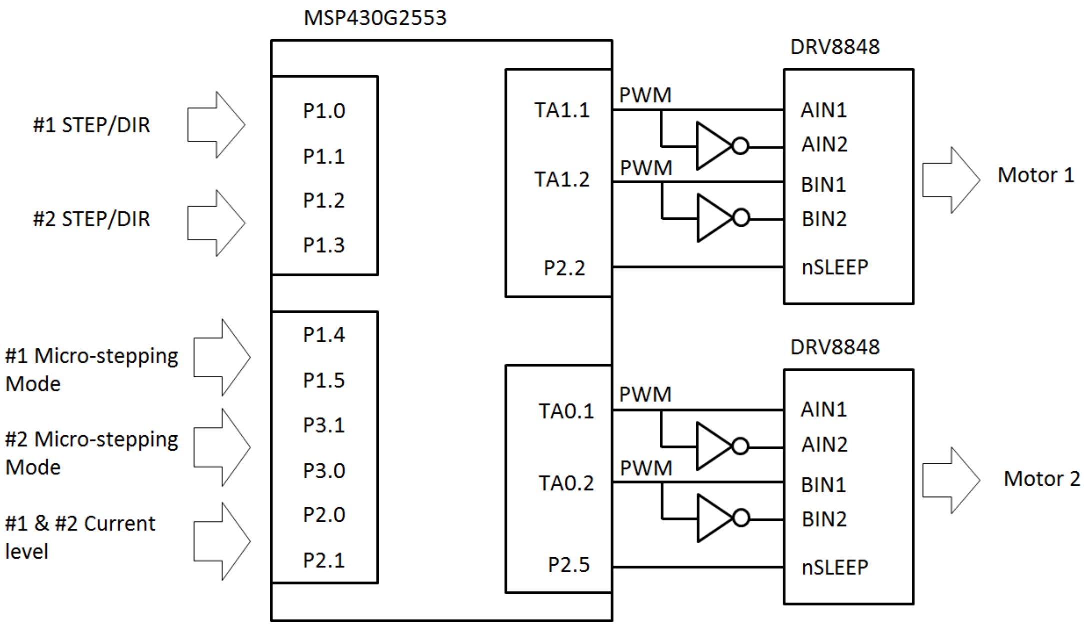


Figure 2. Signals and connection

3. PWM micro-stepping scheme

The following picture shows the PWM micro-stepping scheme. The output of DRV8848 is modulated by the inputs PWM from AINx and BINx. The duty cycle is changing with the micro-stepping index position and controlled by the MCU with an internal preloaded sine table. 50% duty cycle give zero current to the output in this scheme. The MAX duty cycle need to tuned/selected to the needed current level. It is also related on the motor's impedance parameters and the supply voltage. The MIN duty cycle is just calculated as 1-MAX duty. AIN1 and AIN2 are always complementary in this design. π/2 phase shift is applied between Phase A and Phase B.

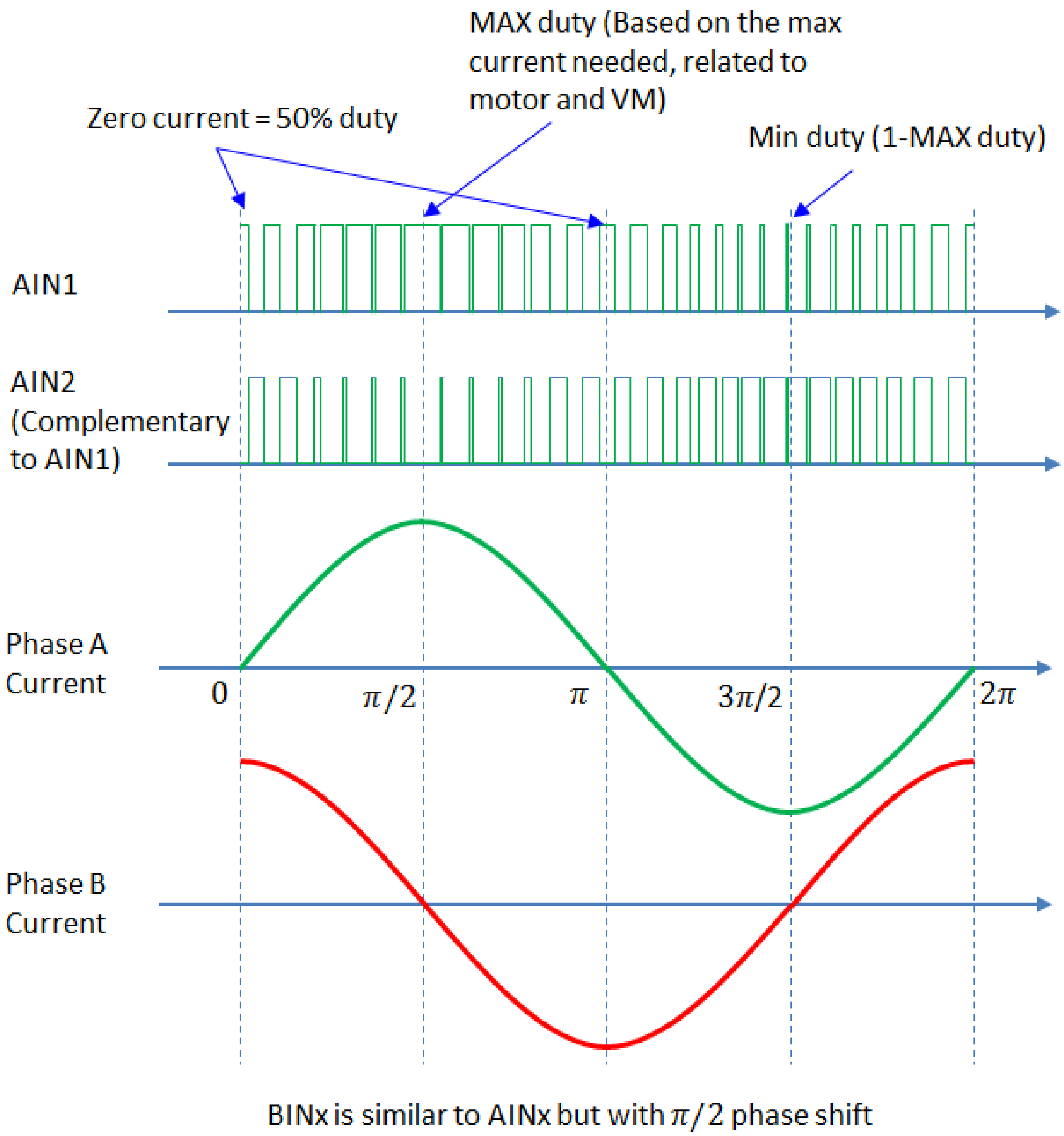


Figure 3. PWM micro-stepping

Although this PWM micro-stepping scheme is using open current control, and the effect of motor back electromotive force is not counted into the model, the output current is tuned out to be very smooth and well controlled with approximate sinusoidal shaping. The most outstanding benefit of the mothed is to get an ultra-low acoustic noise when the PWM frequency is selected >= 20 KHz. In lab test, this module is working much quieter than most other solutions. There is almost no distinguishable audio noise even when put it close to the ear. The PWM micro-stepping mothed can be applied to any low to mid speed range applications requiring smooth and quiet operation.

4. Flow Chart of the Scheme

This basic flow chart can be applied to any MCU platform. Here we use MSP430G2553 which is very cost effective and matching the application. There are two main loops in the algorithm. The main loop is set to read the inputs BITs switches and update the settings. The IRQ loop is excited at every STEP input rising edge and update the output PWM duty cycle based on the index position and DIR (direction) setting. K in the chart is reflecting a coefficient which determines the MAX/MIN duty cycle.

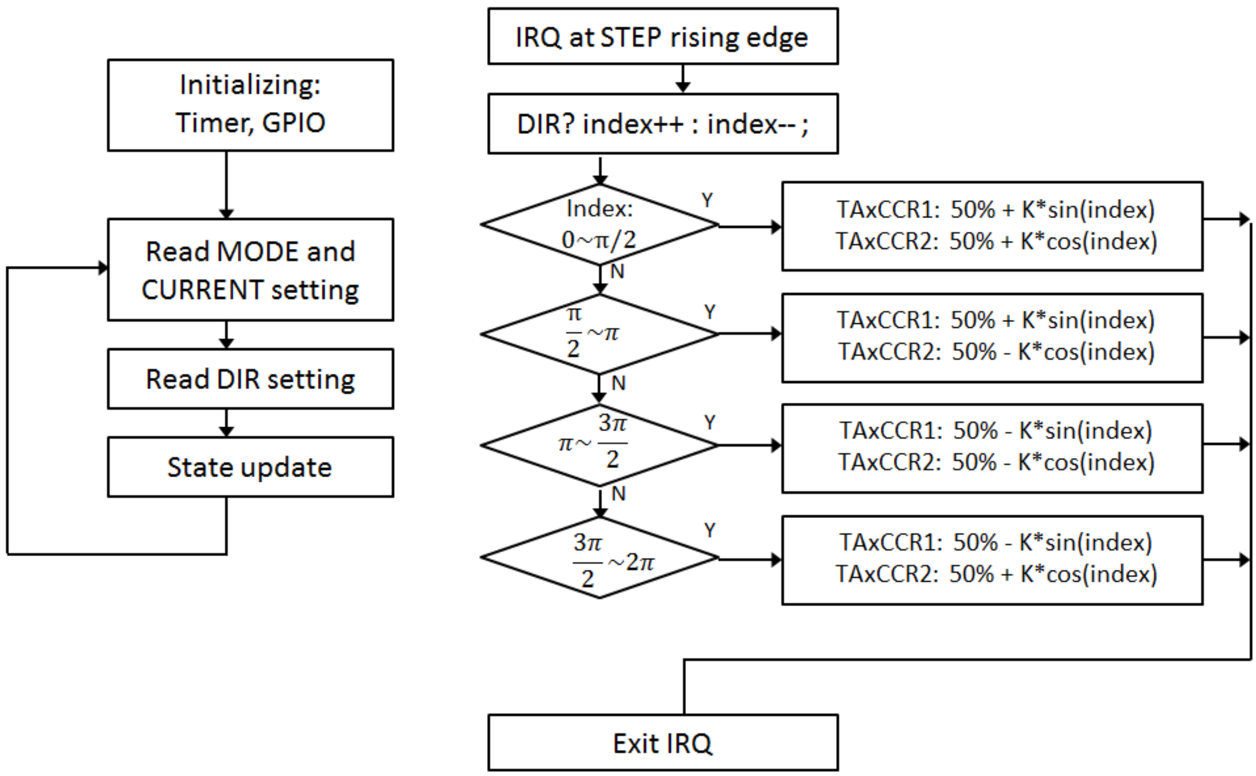


Figure 4. Flow chart

The inputs keys are configured as the following ways.

S1: (for motor 1)

- 00 (00) 1/8 micro-stepping;
- 01 (01) 1/64 micro-stepping;
- 02 (10) 1/128 micro-stepping;
- 03 (11) 1/256 micro-stepping

S2: (for motor 2)

- 00 1/8 micro-stepping;
- 01 1/64 micro-stepping;
- 02 1/128 micro-stepping;
- 03 1/256 micro-stepping

S3: (Current level for both motor 1 and motor2)

00 Level-1 Lowest level, about 0.4A at 12V, 5ohm Phase resistor;
01 Level-2 Mid-low level;
02 Level-3 Mid-high level;
03 Level-4 Highest level, about 1.5A at 12V, 5ohm Phase resistor

5. Lab Test Data

Three different kinds of motors are tested with the module.

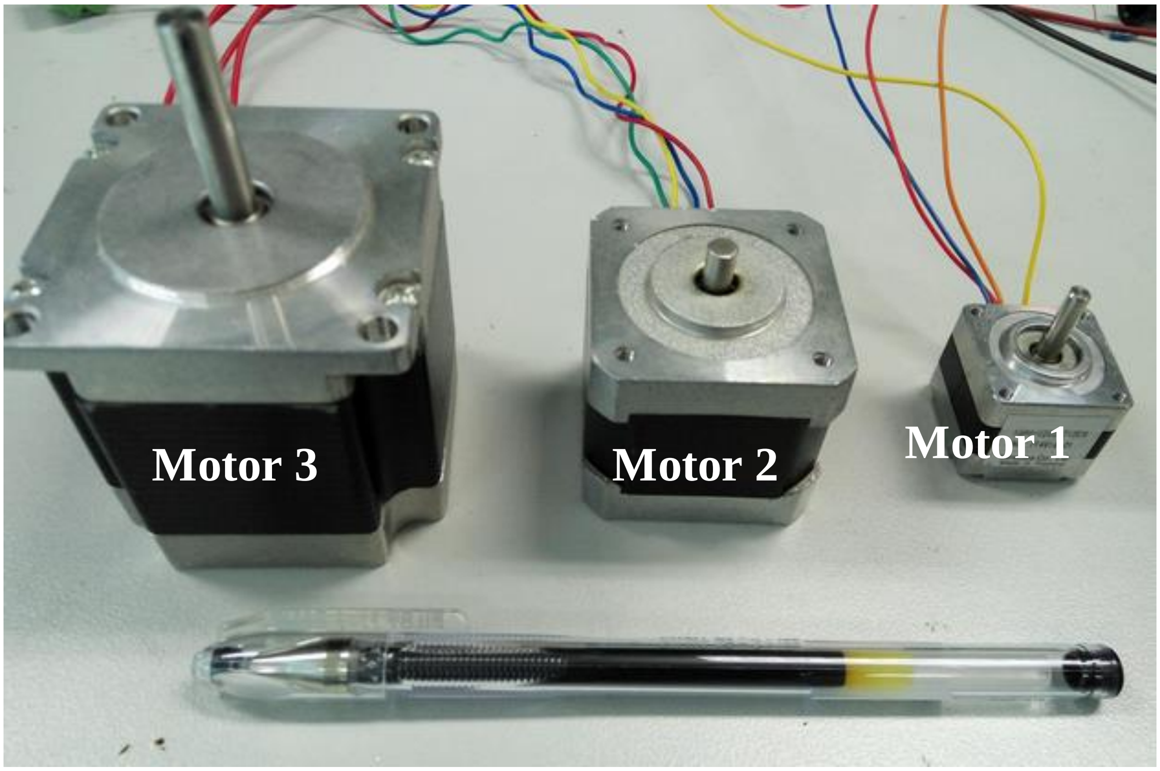


Figure 5. Tested motors

For all the test waveform below, the yellow line is the STEP input. The green line is the phase current. All supply voltage is 12V.

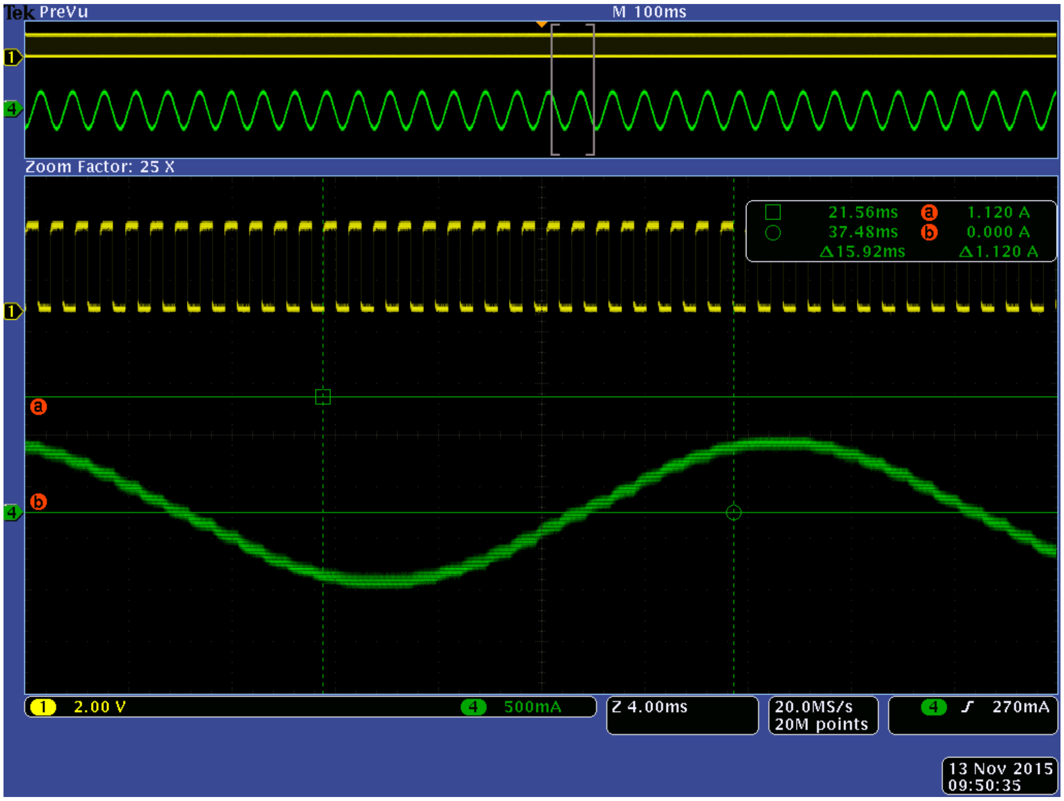


Figure 6. Test waveform (Motor1 1/8 I_level_3)

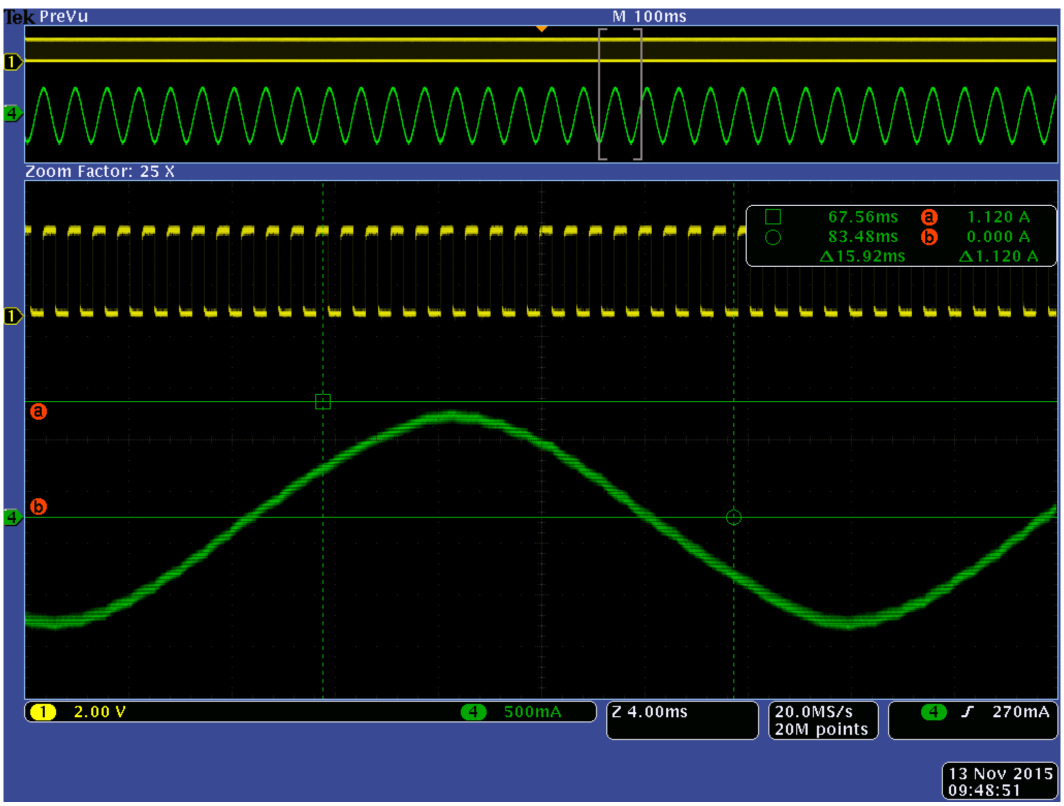


Figure 7. Test waveform (Motor2 1/8 I_level_2)

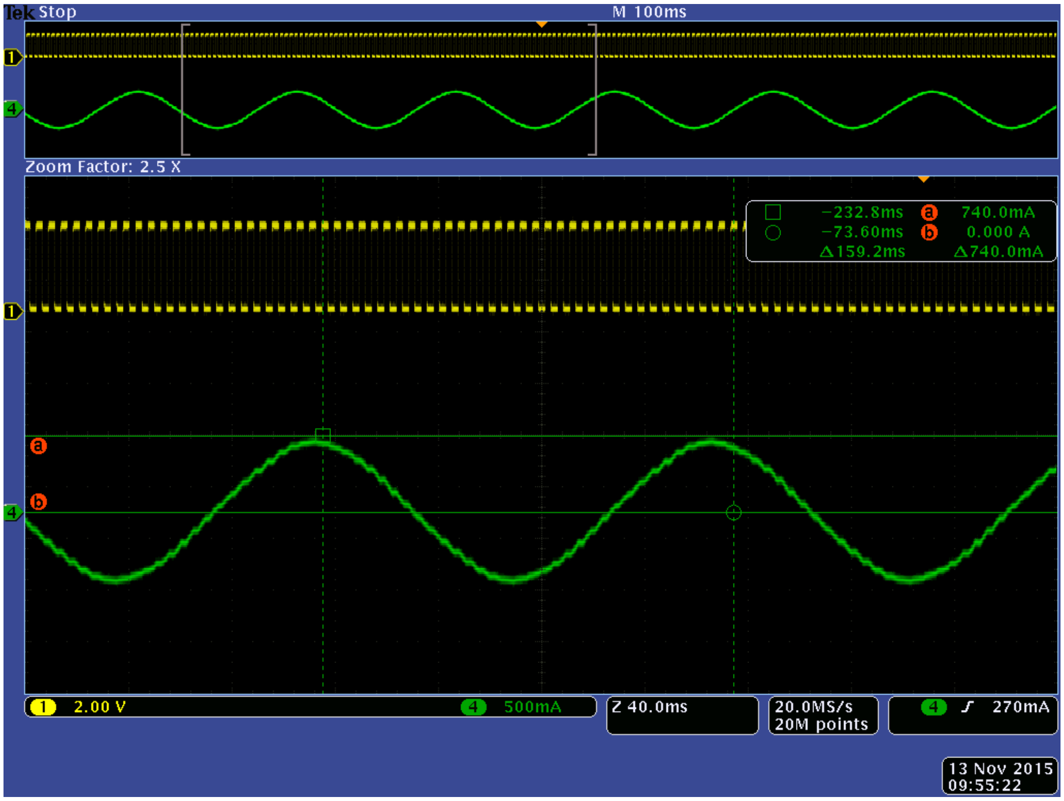


Figure 8. Test waveform (Motor3 1/8 I_level_2)

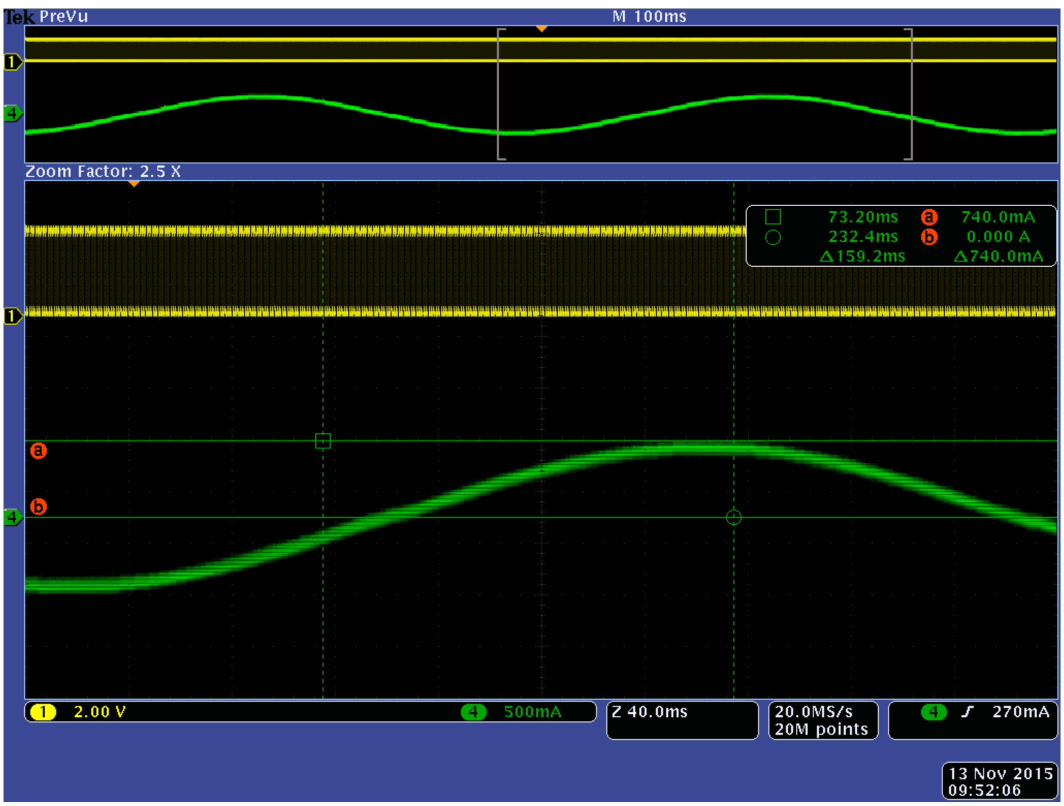


Figure 9. Test waveform (Motor1 1/128 I_level_2)

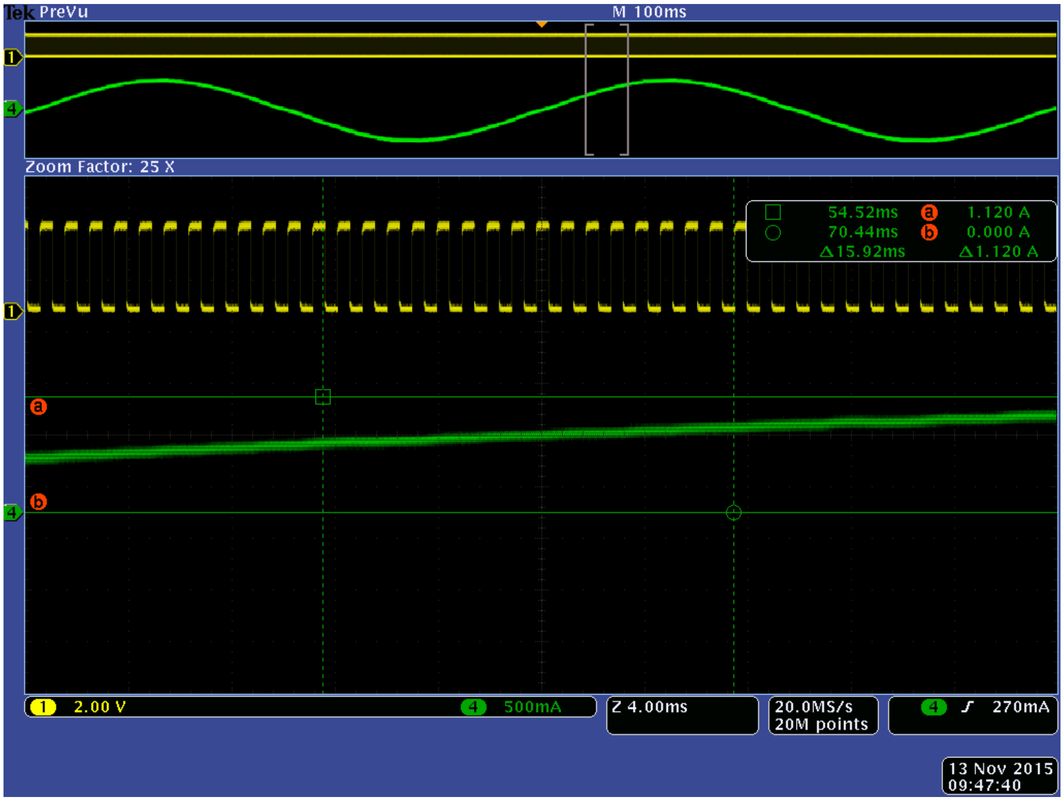


Figure 10. Test waveform (Motor2 1/128 I_level_2)

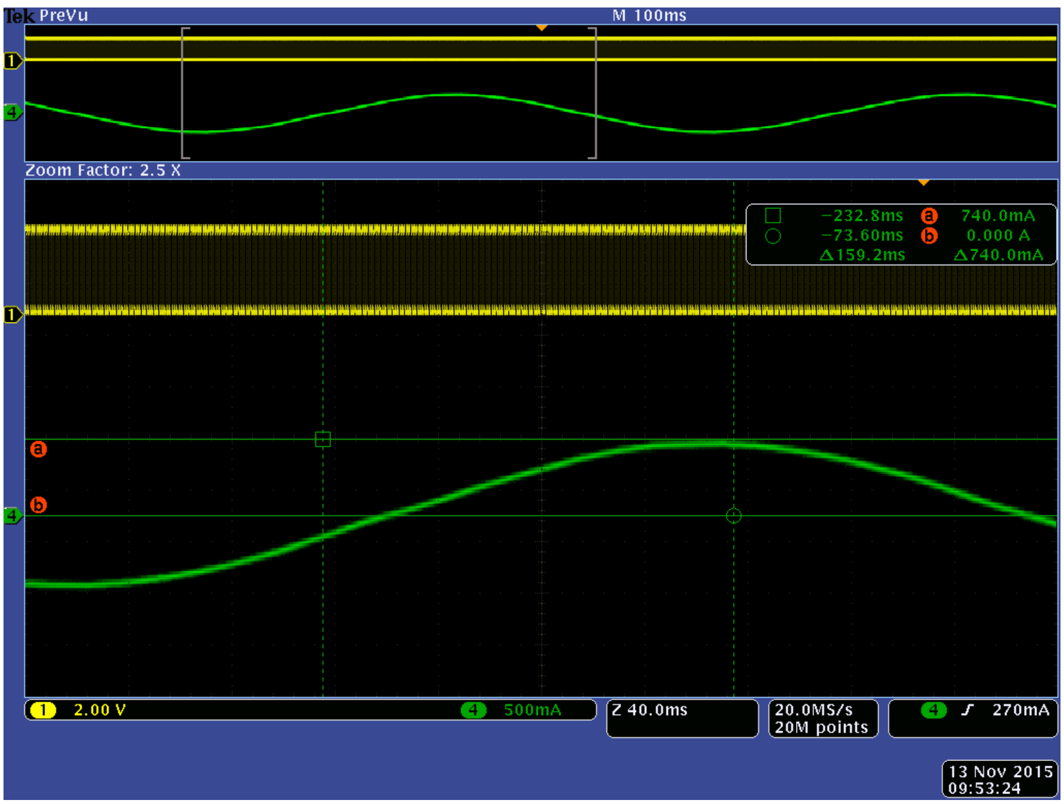


Figure 11. Test waveform (Motor3 1/128 I_level_2)

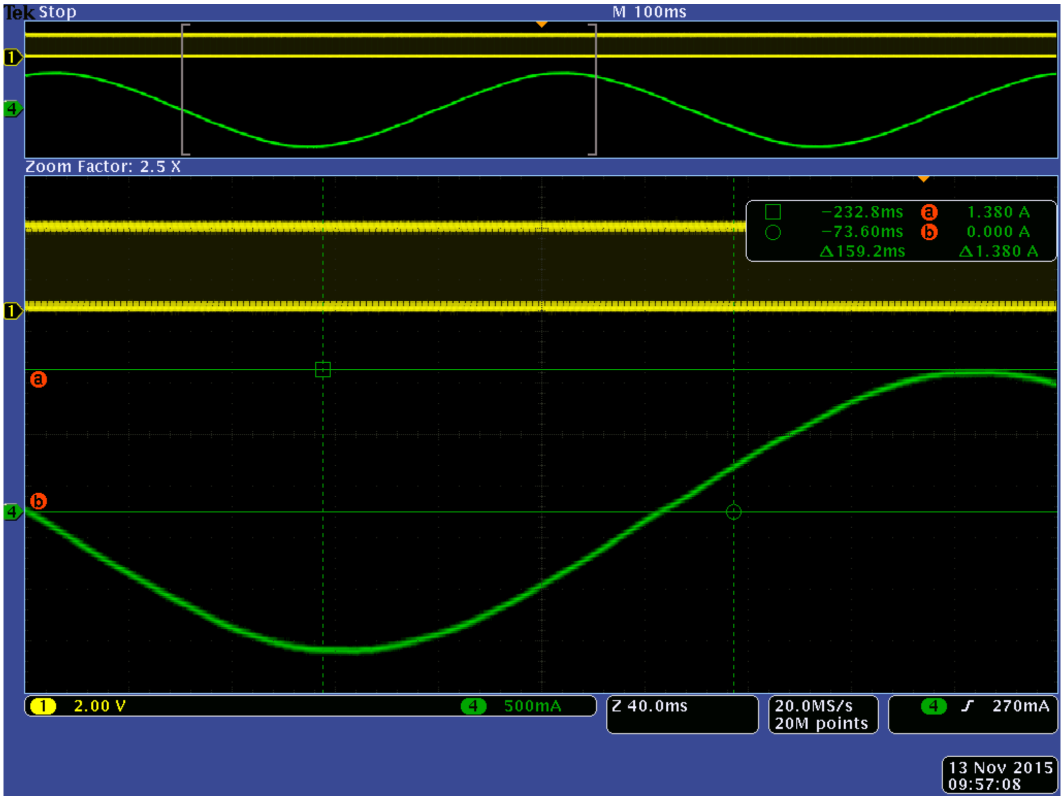


Figure 12. Test waveform (Motor3 1/256 I_level_3)

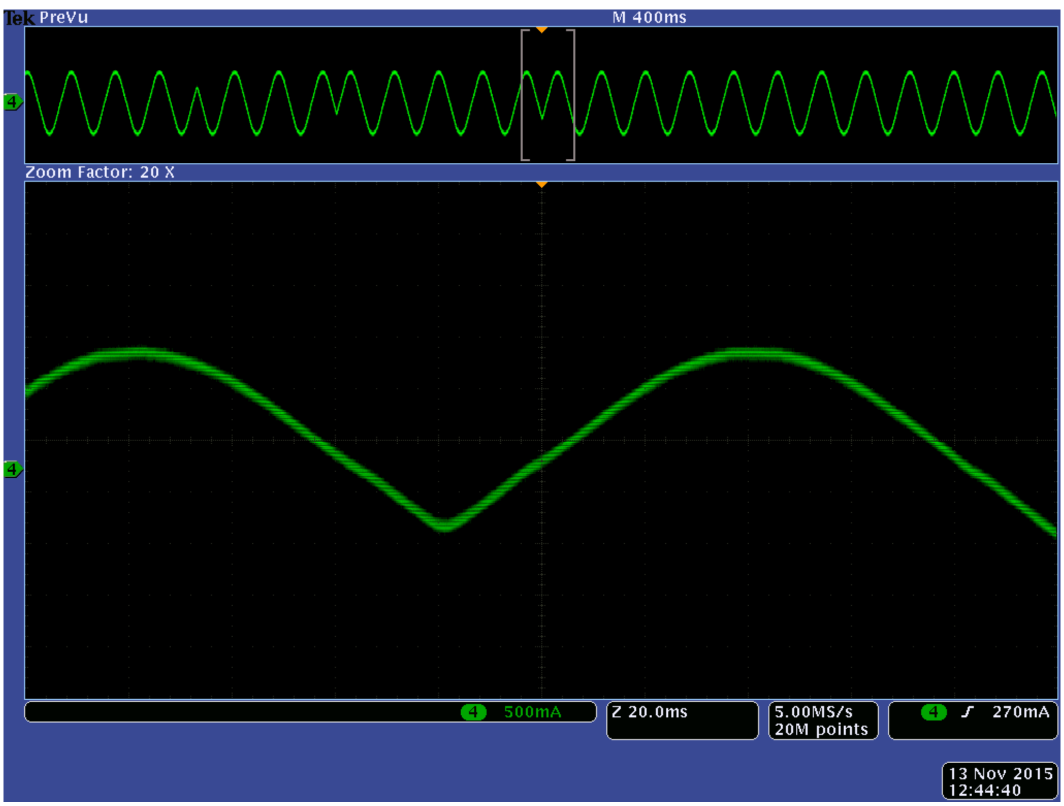


Figure 12. Current waveform when change DIR

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