

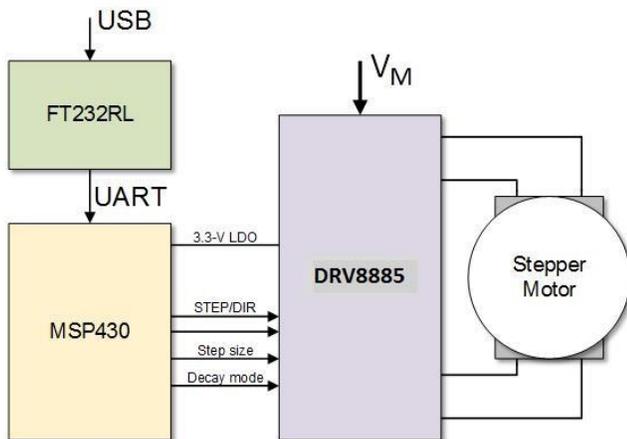
TIDA-00867 24V Stepper Motor Controller with Integrated Current Sense Reference Design

Design Overview

TIDA-00867 showcases the benefits of integrated current sensing for stepper motors. Integrated current sensing eliminates all current sense resistors while providing accurate current regulation. This feature is available in the DRV8885. The DRV8885EVM is used as the demonstration platform for this feature.

Design Resources

TIDA-00867	Design Folder
DRV8885	Product Folder
MSP430F2617	Product Folder

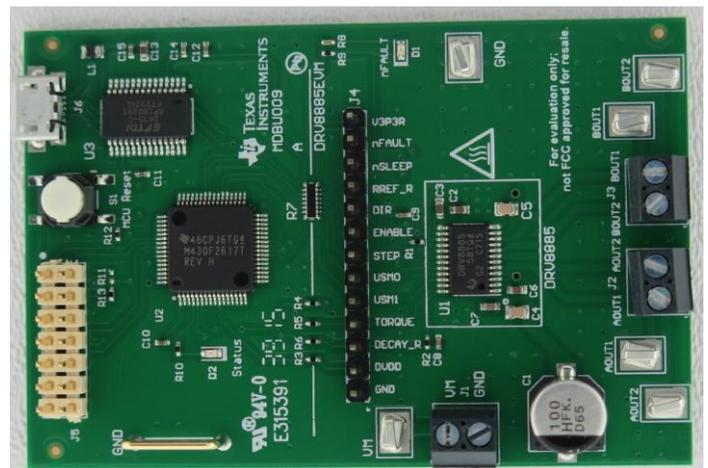


Design Features

- 8.0- to 37-V Operating Supply Voltage Range with up to 1.5-A full-scale continuous motor current
- Integrated Current Sense Functionality
 - No Sense Resistors Required
 - +/- 6.25% Full-Scale Current Accuracy
- Simple GUI for driver input control and motor tuning
- Onboard USB communication for easy connectivity with external controller
- 100 mil header gives test probe access to all driver input controls

Featured Applications

- Multi-Function Printers and Scanners
- Laser Beam Printers
- 3D Printers
- Automatic Teller and Money Handling Machines
- Video Security Cameras
- Office Automation Machines
- Factory Automation and Robotics



1. Introduction

Traditional stepper motor drivers rely on external resistors to monitor the current through each winding. The current creates a voltage across the resistor that is monitored by an internal comparator. The comparator voltage reference is changed based on the desired current and location in the index table.

Recently, some stepper motor drivers have integrated current regulation inside the device. One method is to integrate the current sense resistors into the package or by comparing the voltage across current sense FETs in parallel with the low-side drivers. Integrating the current sense resistors reduces the number of external components, but also causes the heat generated by the resistor to move inside the package.

Another method is to use current sense FETs to monitor current instead of current sense resistors. This eliminates the cost of two external sense resistors and saves PCB area, which in turn helps with design layout and manufacturability. Assuming the internal $R_{DS(ON)}$ of the devices are the same, extra heat may also be reduced. In a constrained environment using multiple stepper motor drivers, this may reduce the need for additional heatsinking in the system.

Using the DRV8885 motor driver, this design demonstrates the ability to regulate current with integrated current sense FETs.

2 Test Data

2.1 Current Comparison

The DRV8885 and DRV8880 were chosen for this comparison because the two devices can be configured with the same decay and off times. The variables in the data are reduced to the current regulation method and the $R_{DS(ON)}$ differences between the two devices.

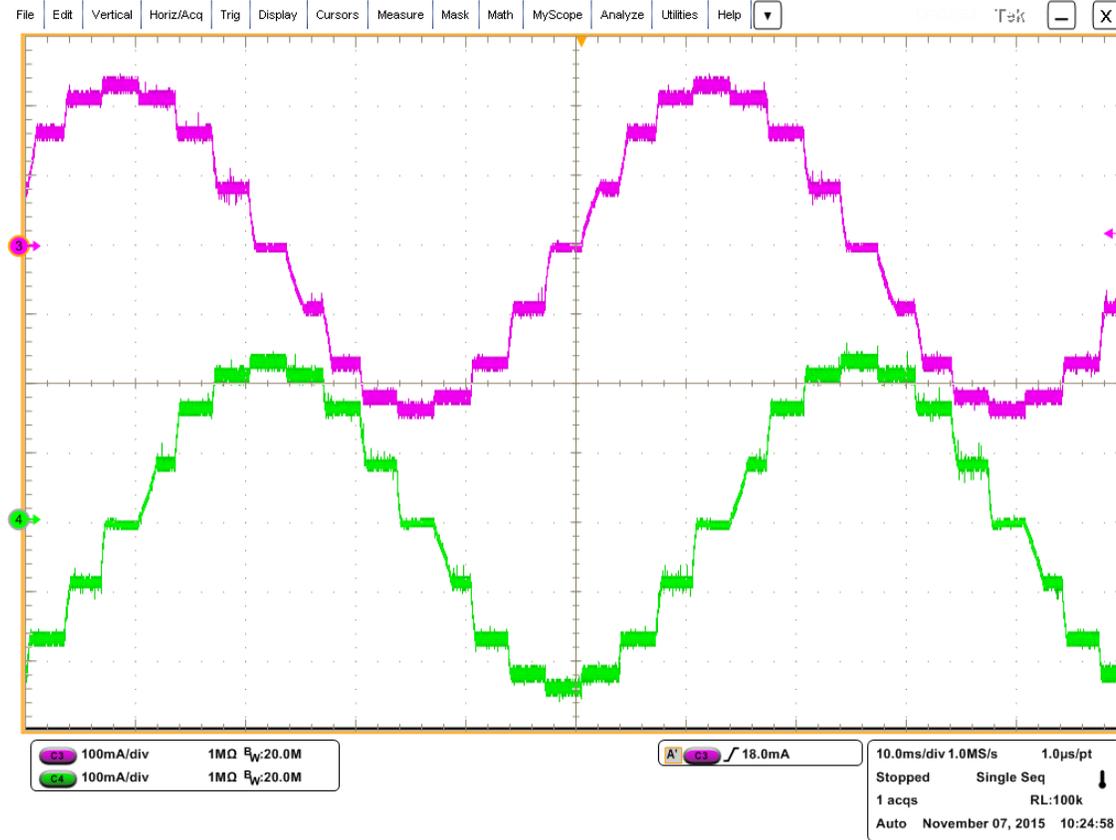
- Both the DRV8885 and DRV8880 are set to “Mixed decay: 30%” mode for both increasing and decreasing steps.
- Both the DRV8885 and DRV8880 are set to 20 μ s PWM off time.
- The DRV8885 $R_{DS(ON)}$ (860 m Ω typical) is higher than the DRV8880 $R_{DS(ON)}$ (630 m Ω typical). This can account for the additional heat in the device.

NOTE: The recommended decay setting for the DRV8880 is AutoTune. AutoTune was not used to allow comparison of current accuracy of the two methods. The AutoTune setting selects the decay mode for minimal current ripple across voltage and motor inductance variations.

The following scope captures compares motor performance with internal current sensing versus the more traditional usage of external sense resistors. Three motors were used to regulate different current at different levels and motor inductances.

MOTOR 1

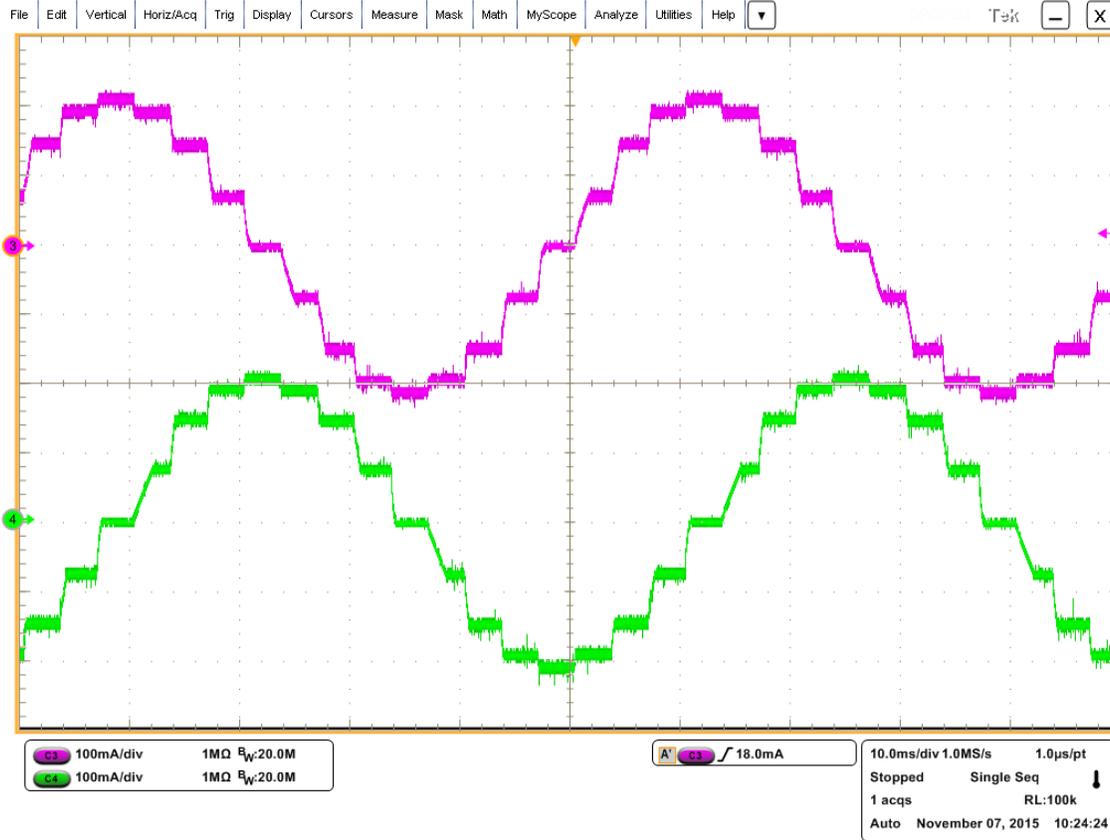
System Voltage	24	Volts
Current Setting	0.23	Amps
Speed	300	Steps/second @ 1/4μsteps
Motor 1 Specifications		
Manufacturer	Portescap	
Model Number	42M048C2B	
Resistance per Phase +/- 10%	52.4	Ohms
Inductance per Phase, typ	85.7	mH
Rated Current per Phase	0.23	Amps



Channel 4 – AOUT1

DRV8885

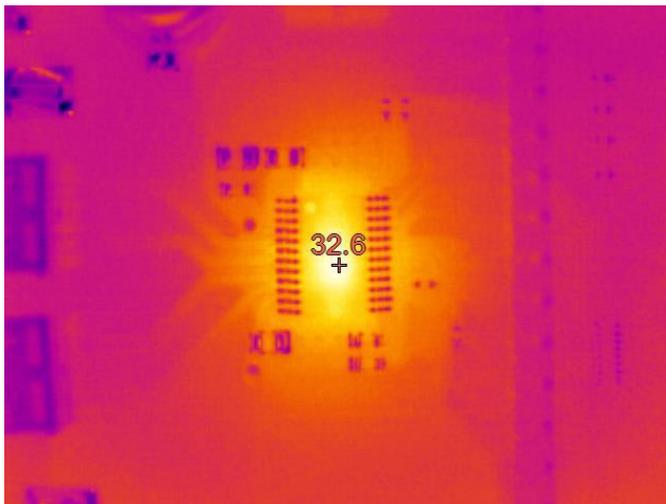
Channel 3 – BOUT1



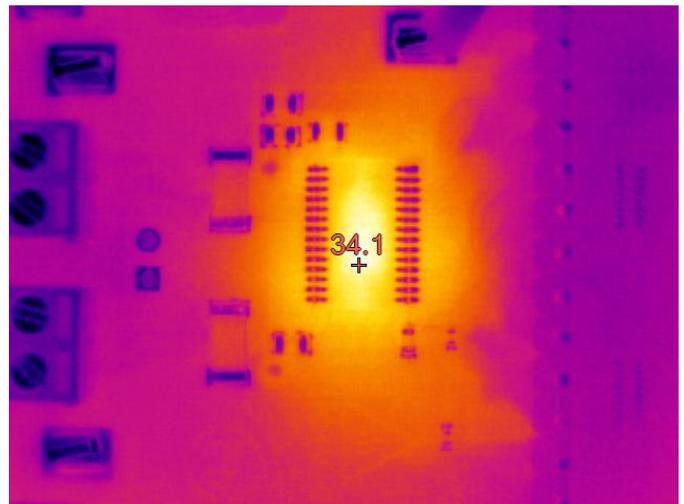
DRV8880

Channel 4 – AOUT1

Channel 3 – BOUT1



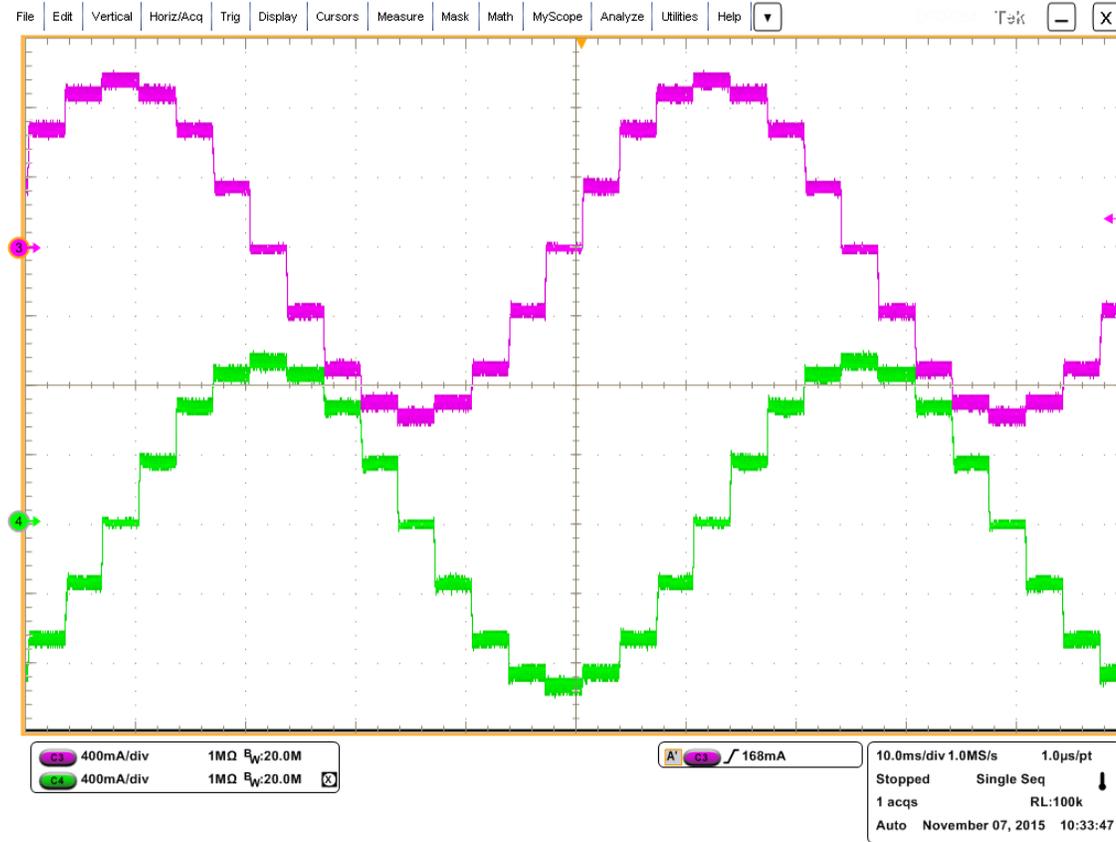
DRV8885



DRV8880

MOTOR 2

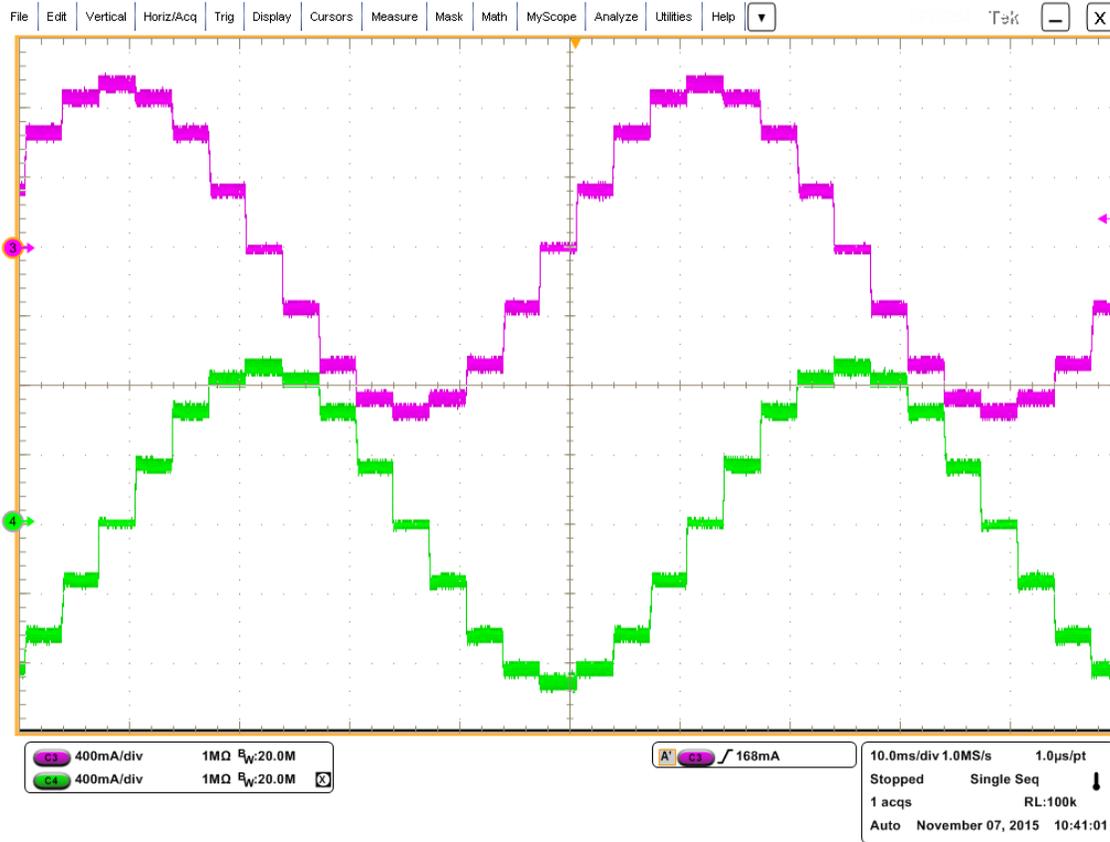
System Voltage	24	Volts
Current Setting	1.0	Amps
Speed	300	Steps/second @ 1/4μsteps
Motor 2 Specifications		
Manufacturer	Trinamic	
Model Number	QSH4218-41-10-035	
Resistance per Phase at 20°C	4.5	Ohms
Inductance per Phase, typ	7.5	mH
Rated Current per Phase	1.0	Amps



Channel 4 – AOUT1

DRV8885

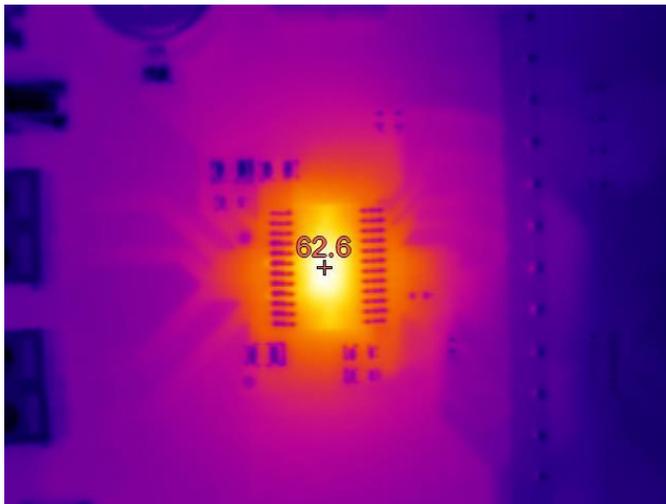
Channel 3 – BOUT1



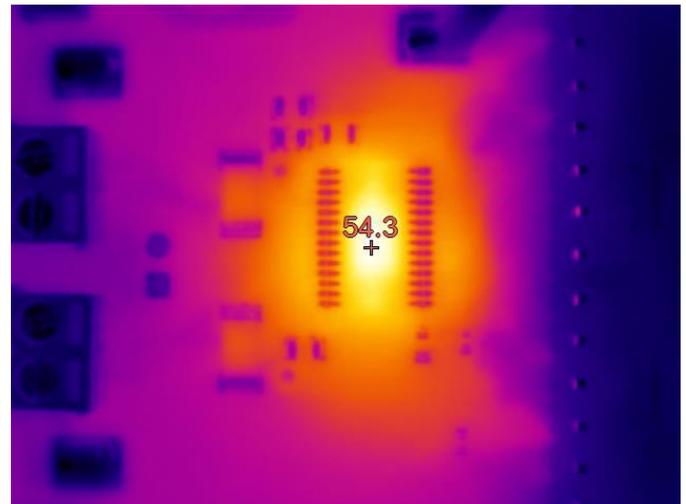
DRV8880

Channel 4 – AOUT1

Channel 3 – BOUT1



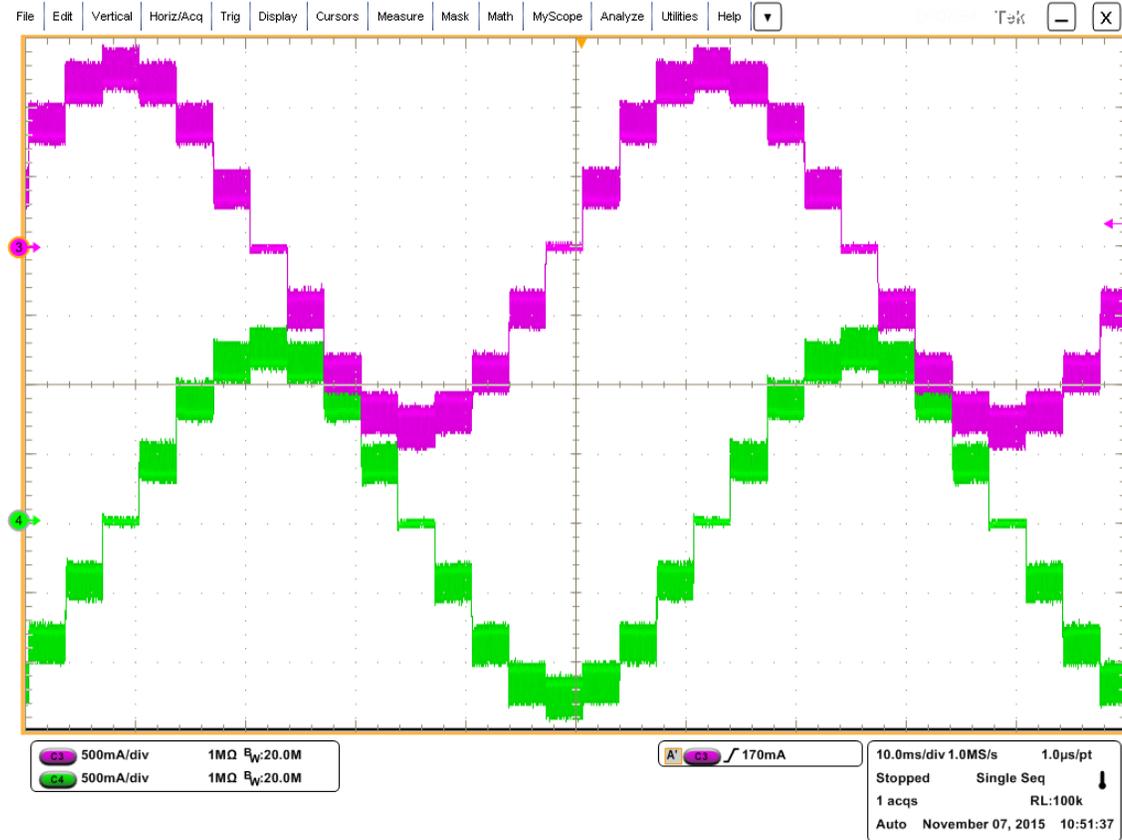
DRV8885



DRV8880

MOTOR 3

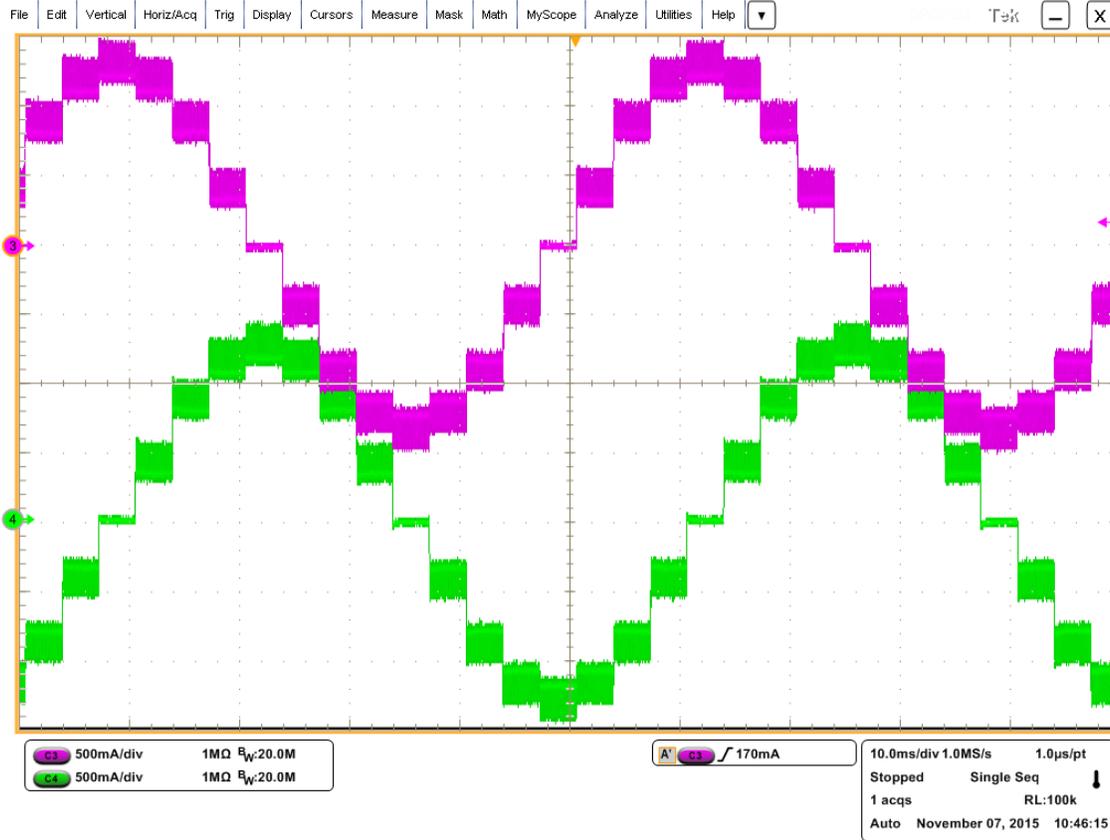
System Voltage	24	Volts
Current Setting	1.5	Amps
Speed	300	Steps/second @ 1/4μsteps
Motor 3 Specifications		
Manufacturer	Trinamic	
Model Number	QSH5718-41-28-055	
Resistance per Phase at 20°C	0.7	Ohms
Inductance per Phase, typ	1.4	mH
Rated Current per Phase	1.5	Amps



DRV8885

Channel 4 – AOUT1

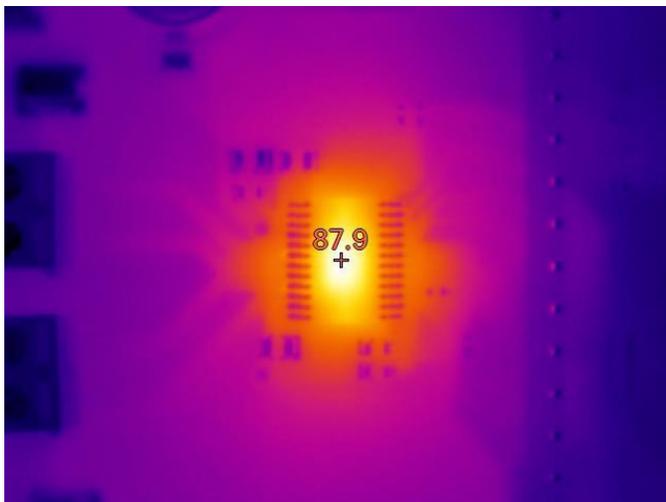
Channel 3 – BOUT1



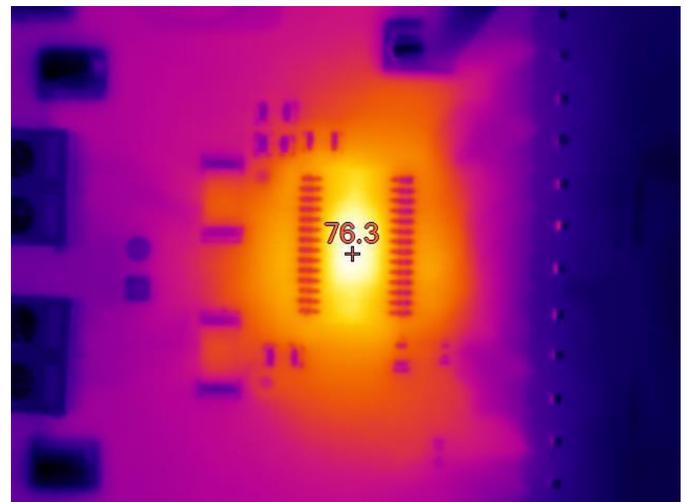
DRV8880

Channel 4 – AOUT1

Channel 3 – BOUT1



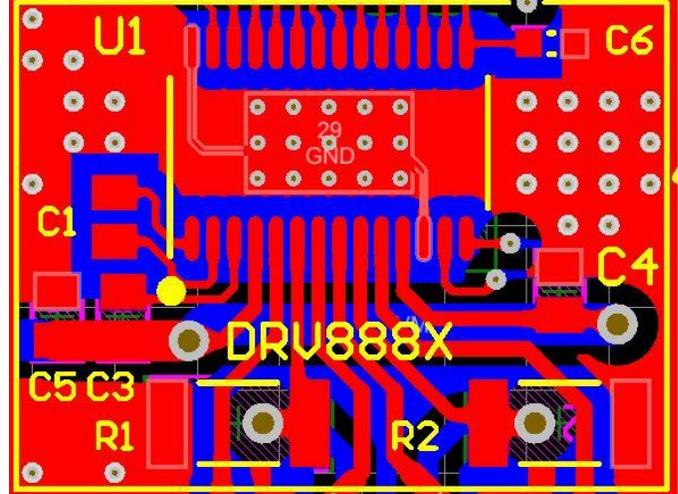
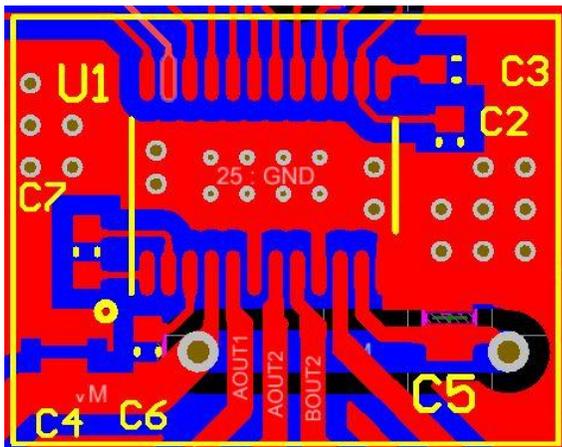
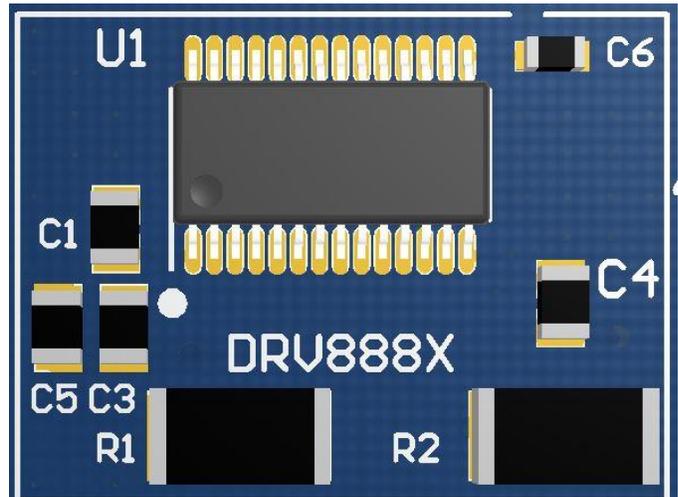
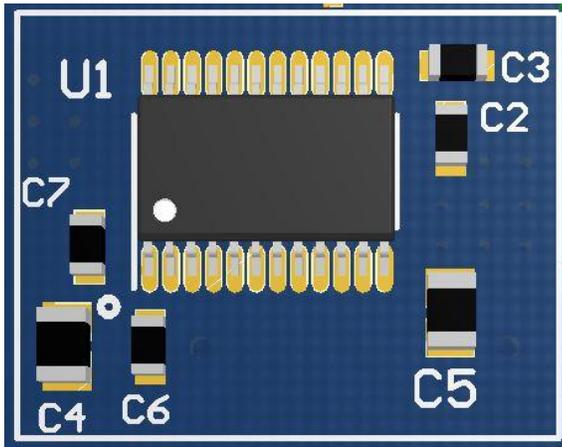
DRV8885



DRV8880

2.2 Additional Benefits

Comparing the DRV8885EVM with the DRV8880EVM illustrates the component savings, and the potential PCB area savings when using integrated current sensing. It is important to note the lack of sense resistors on the DRV8885EVM as compared to the DRV8880EVM. The DRV8885 also has fewer pins than the DRV8880 allowing for a smaller package.



DRV8880

DRV8885

3D and 2D layout, respectively, of DRV8885 and DRV8880 for comparison. Dimensions are scaled for proper comparison

X	650	mils
Y	510	mils
Area	331500	sq mils
Area	0.3315	sq inches

X	790	mils
Y	590	mils
Area	466100	sq mils
Area	0.4661	sq inches

3. About the Author

Rick Duncan is an Applications Engineer for Texas Instrument's motor drive business, where he is responsible for supporting TI's motor drive portfolio. Rick graduated from Louisiana State University with a Bachelor's of Science in Electrical Engineering.

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