12V BLDC Server Fan with Sensor-less Sinusoidal Control

This reference design is a 12V 3-phase brushless DC fan, and is based around a single IC, the DRV10975. This device integrates all the essential components of sensor-less BLDC motor control: the back-EMF sensing and commutation engine, overcurrent, under-voltage, and thermal protection features, sinusoidal current control, a single-input for the speed command, and an output power stage capable of 1.5A continuous and 2A peak current.

The design is cost-optimized while high-performance, using minimal components and a form-fitting PCB. It fits well onto the Sunon BLDC fan model SG40281B1.

The tuned register settings of the DRV10975 are provided with this design in a .csv file, which can be written to the device EEPROM, or directly imported to the DRV10983-75 GUI. For information on programming the EEPROM, refer to the DRV10975 datasheet.

This test report provides typical characteristics of this BLDC fan with an applied VCC of 6V to 14V.

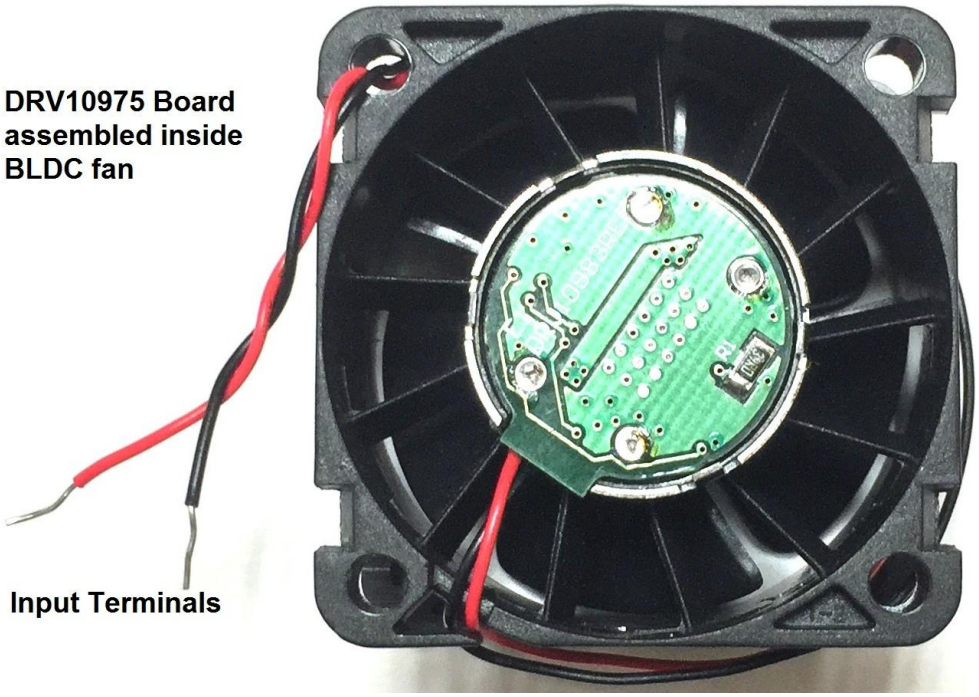

Figure 1: 12V BLDC server fan design

1. Input Current, Power and Speed Characterization: These tests were performed to characterize current, power, and rotational speed for each applied VCC voltage. The duty cycle was fixed at 99%, and speed was varied by changing the input VCC from 6V to 14V in 1V steps. The data shows that speed changes fairly linearly with VCC.

VCC	ICC	Input power	Motor electrical speed	Motor physical speed (electrical /2 *60) 4-pole motor
6V	0.25A	1.5W	363Hz	10893 RPM
7V	0.31A	2.2W	418Hz	12531 RPM
8V	0.36A	2.9W	470Hz	14088 RPM
9V	0.41A	3.7W	529Hz	15876 RPM
10V	0.46A	4.6W	580Hz	17388 RPM
11V	0.52A	5.7W	623Hz	18693 RPM
12V	0.58A	7.0W	673Hz	20196 RPM
13V	0.65A	8.5W	724Hz	21714 RPM
14V	0.7A	9.8W	778Hz	23334 RPM

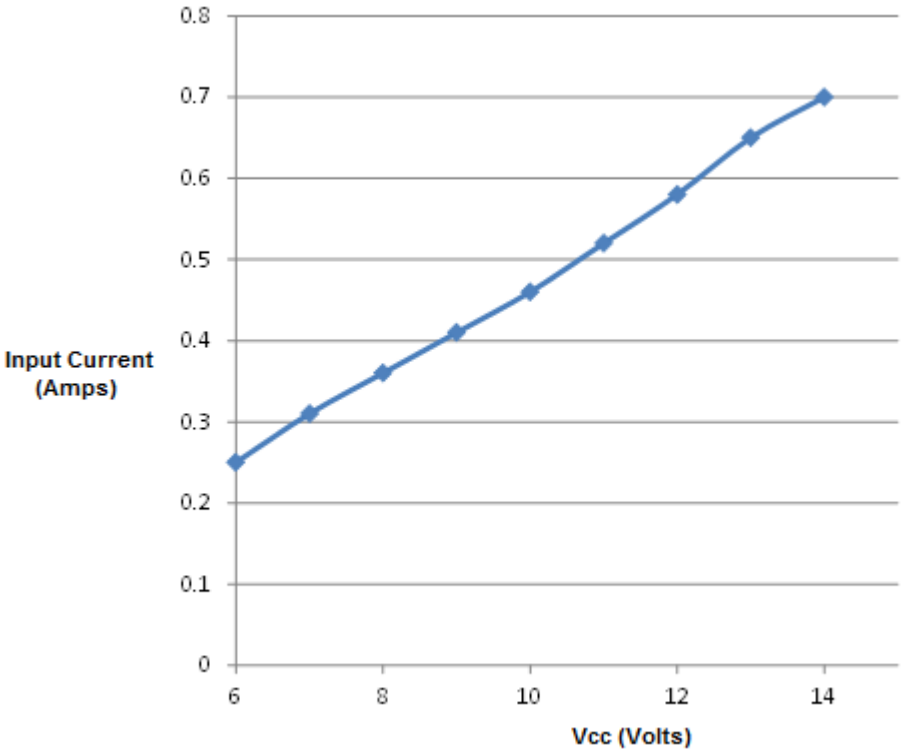

Figure 2: Input Current with respect to Vcc

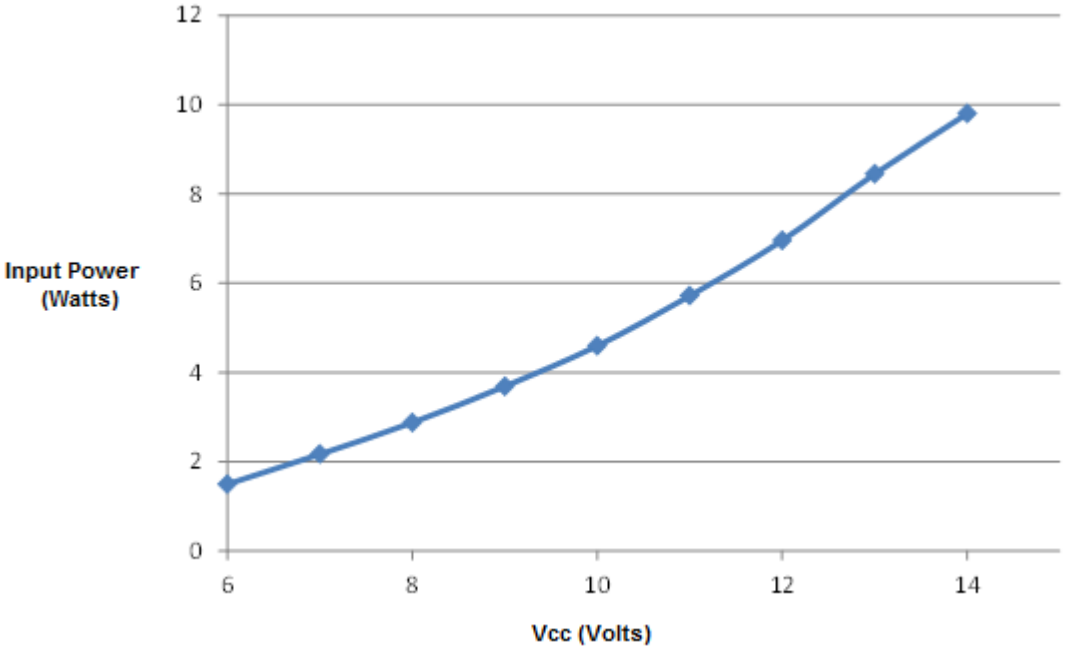

Figure3: Input power with respect to Vcc

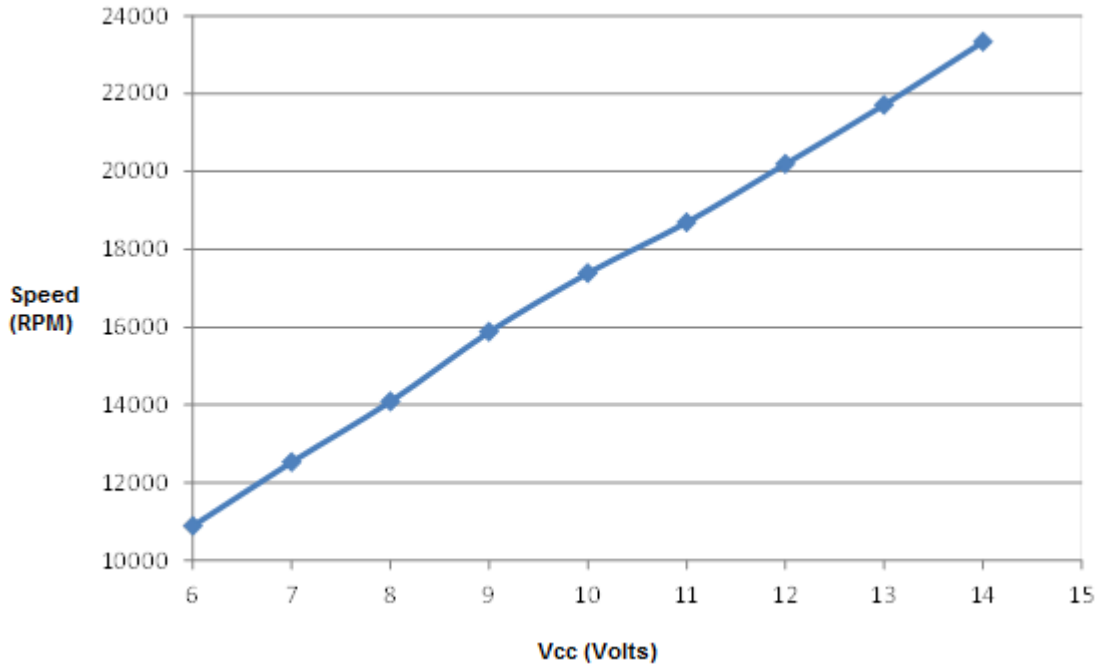

Figure4: Motor Speed with respect to Vcc

2. Motor phase voltage and current waveforms: Figures 5, 6, and 7 show the three phase voltages with respect to GND, and current flowing through the W-phase of motor.

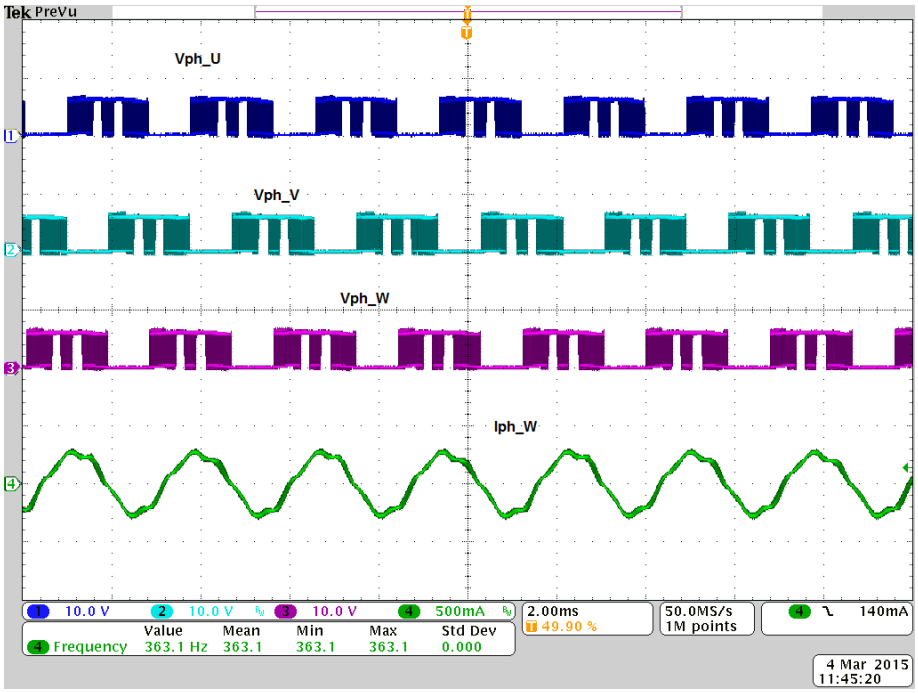

Figure 4: Motor Phase voltage and current at 6V 10983RPM

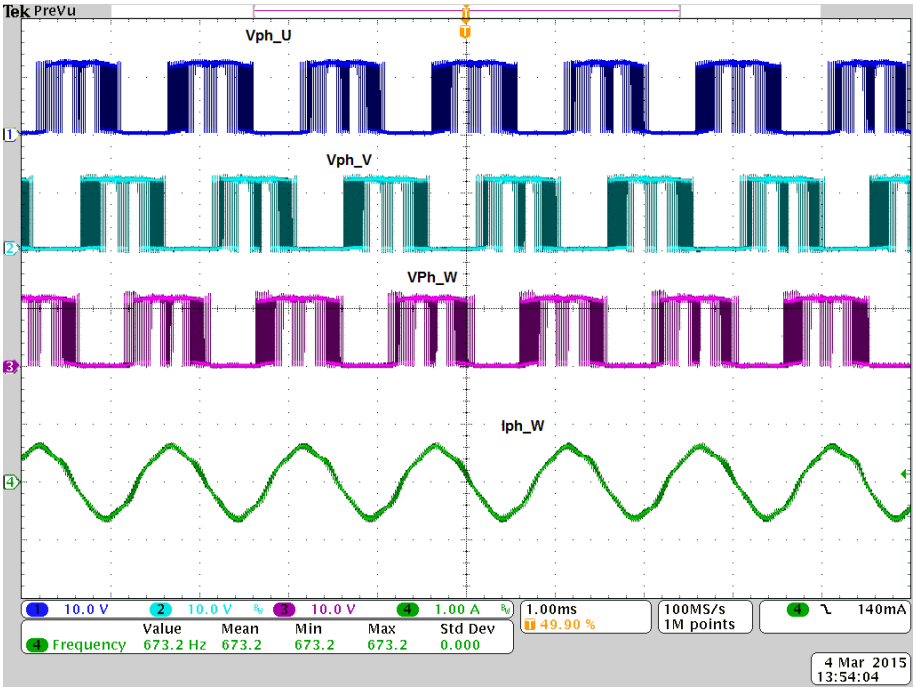

Figure 5: Motor Phase voltage and current at nominal 12V 20196RPM

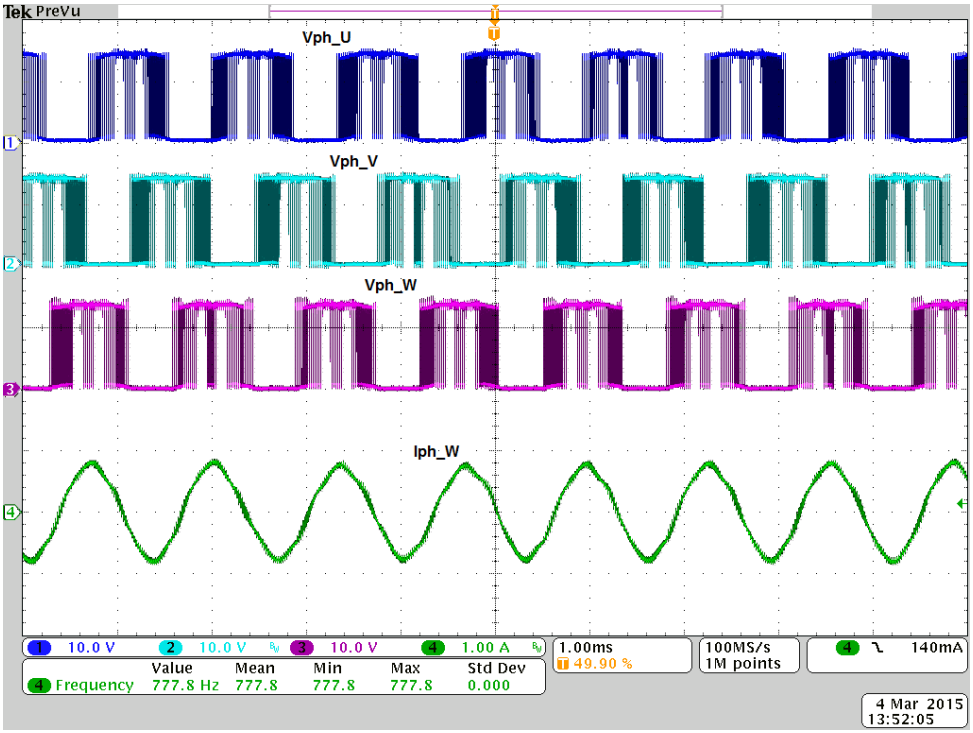

Figure 6: Motor Phase voltage and current at maximum 14V 23334RPM

3. Thermal Image of test board: Figure 7 shows a thermal image with the fan running at 12V 20196RPM. The ambient is at room temperature 25°C. The fan blades are designed to create air suction, which helps remove heat from the PCB. The temperature in the vicinity of the DRV10975 is 52°C, and the max temperature is 62°C near resistor R1.

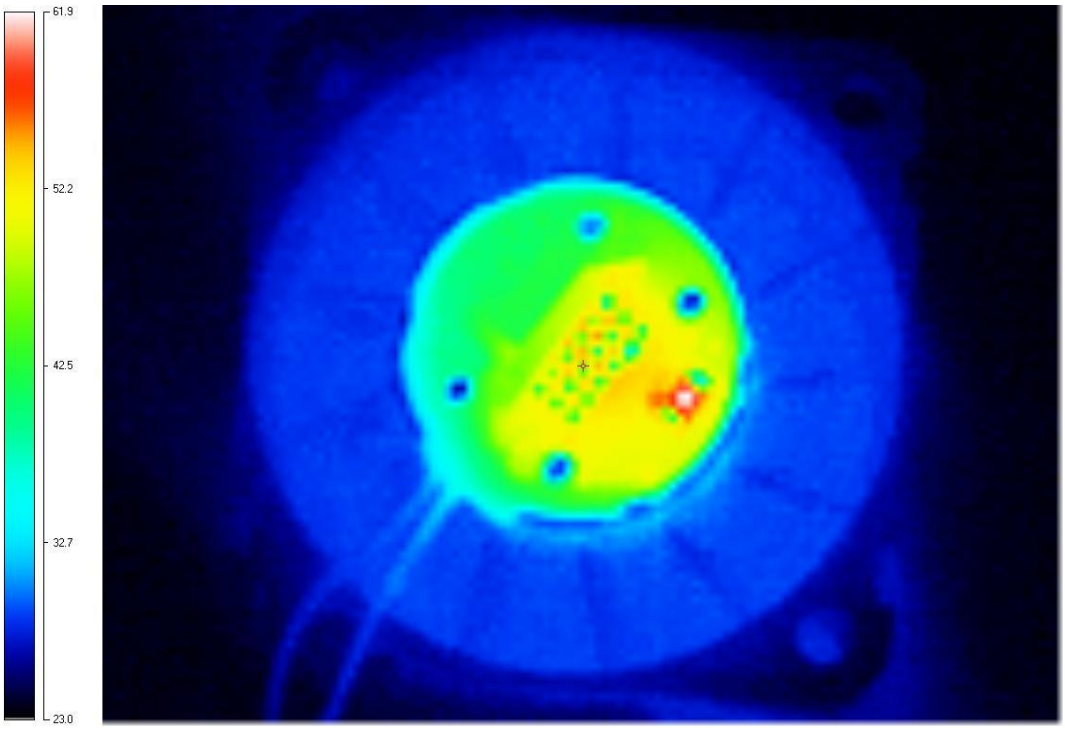

Figure 7: PCB top side thermal image at 12V 20196RPM

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265