# 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.

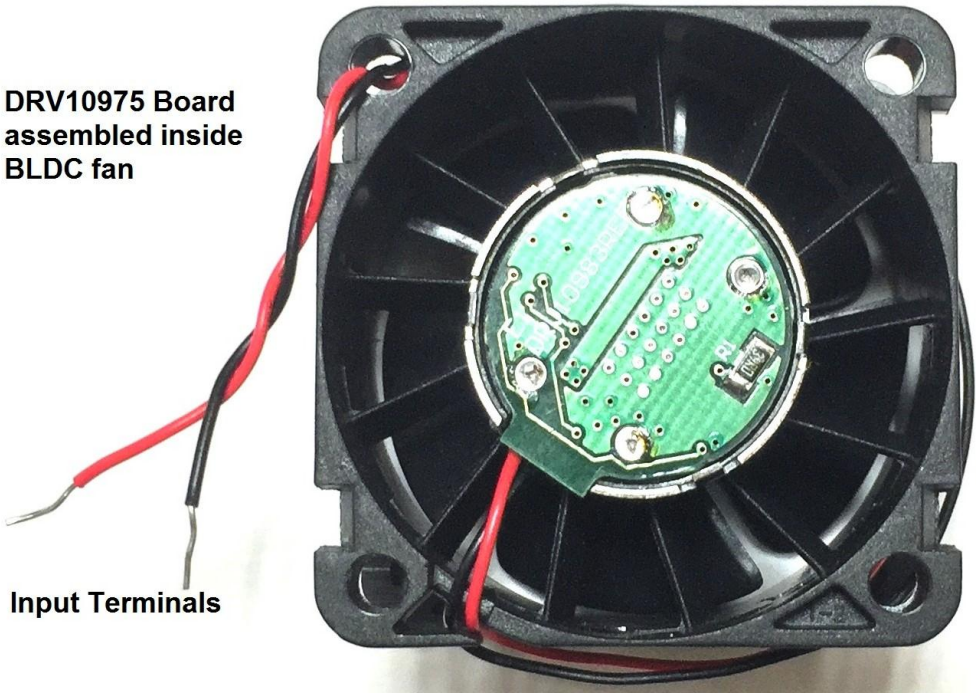


Figure 1: 12V BLDC server fan design

**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 |

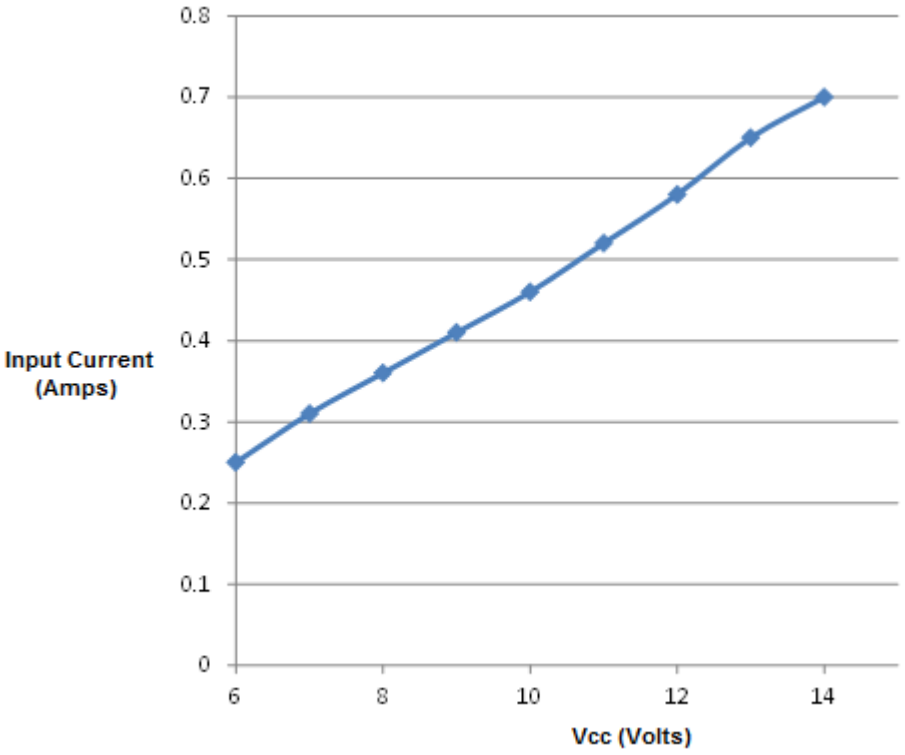


Figure 2: Input Current with respect to Vcc

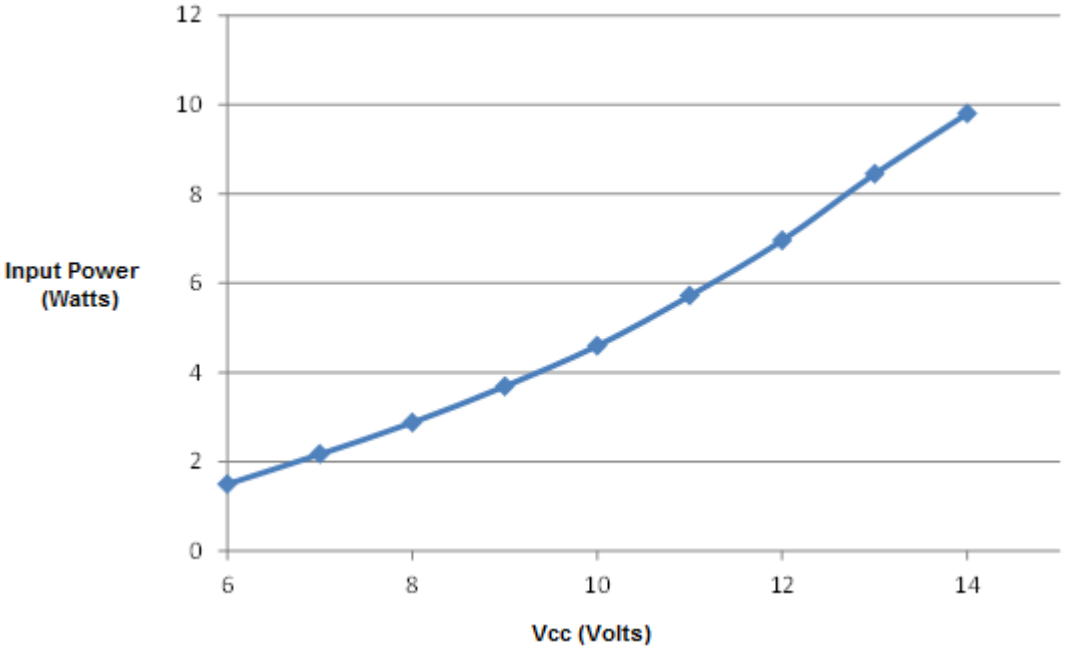


Figure3: Input power with respect to Vcc

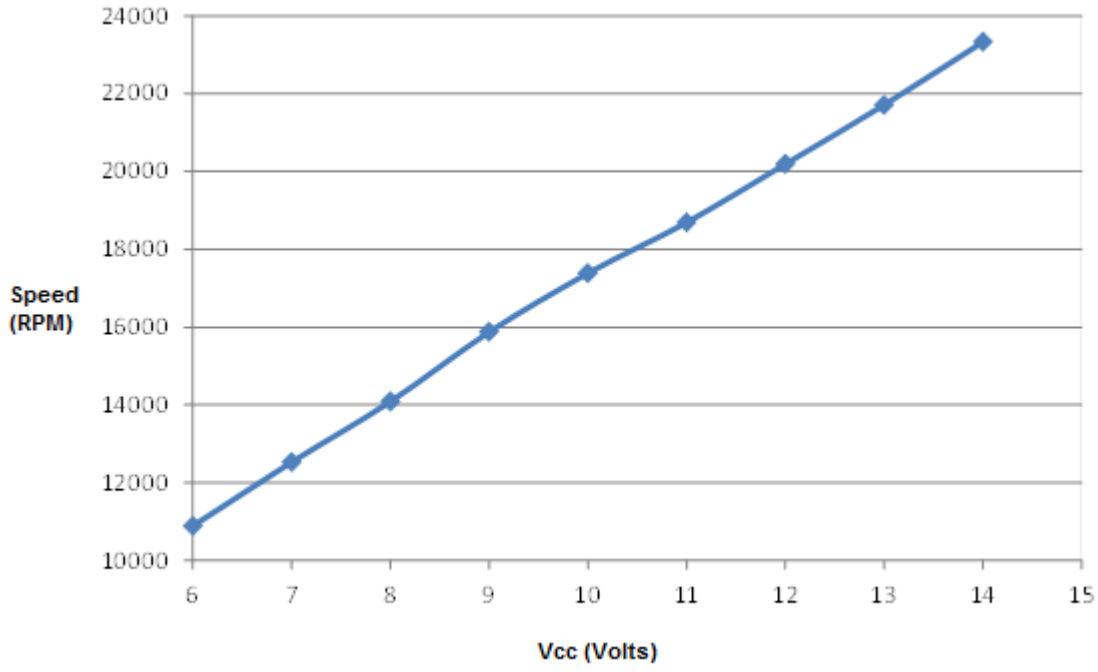


Figure4: Motor Speed with respect to Vcc

**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.

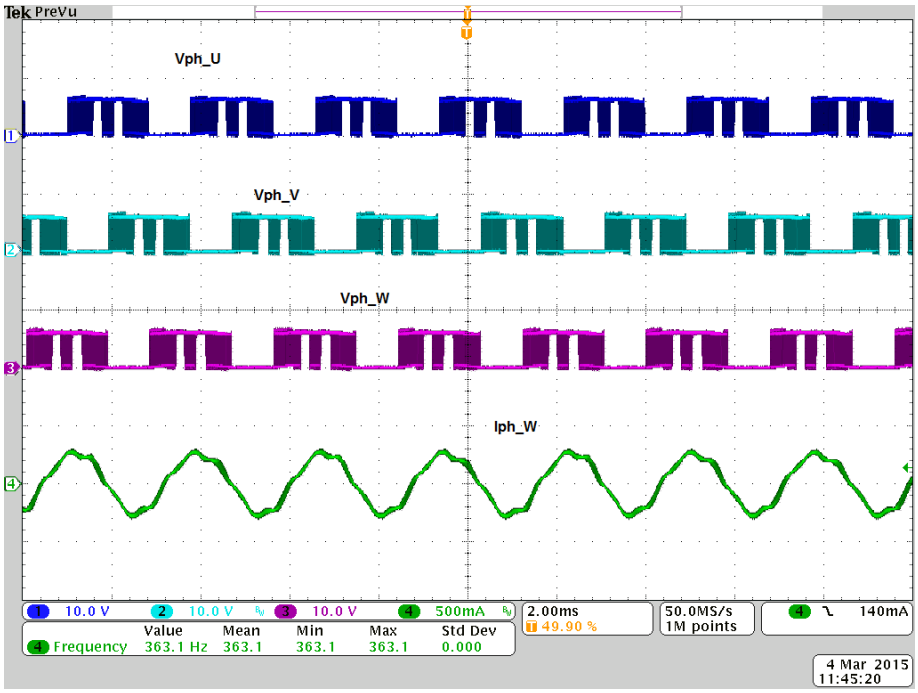


Figure 4: Motor Phase voltage and current at 6V 10983RPM

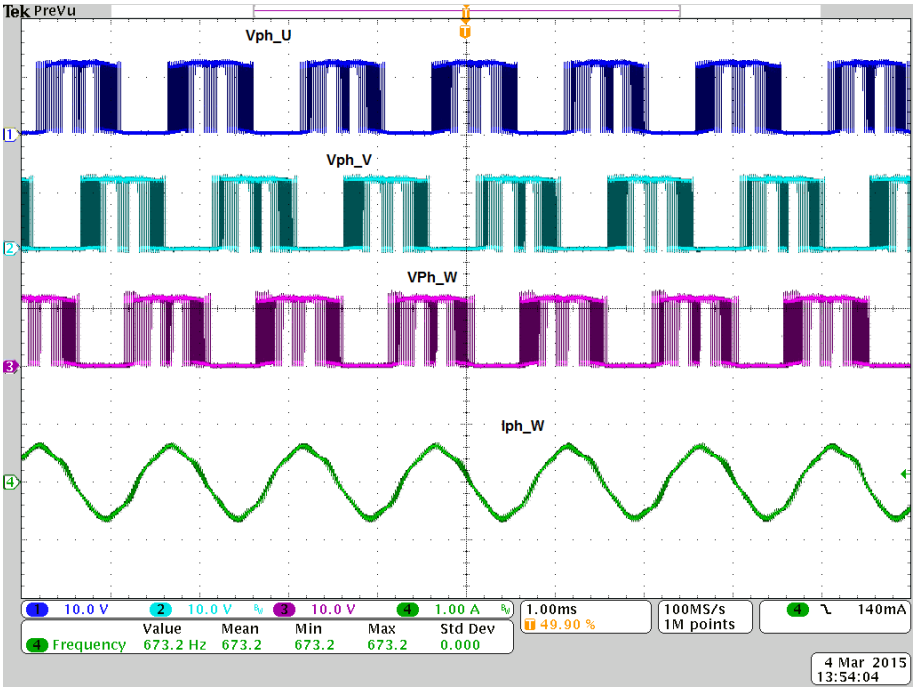


Figure 5: Motor Phase voltage and current at nominal 12V 20196RPM

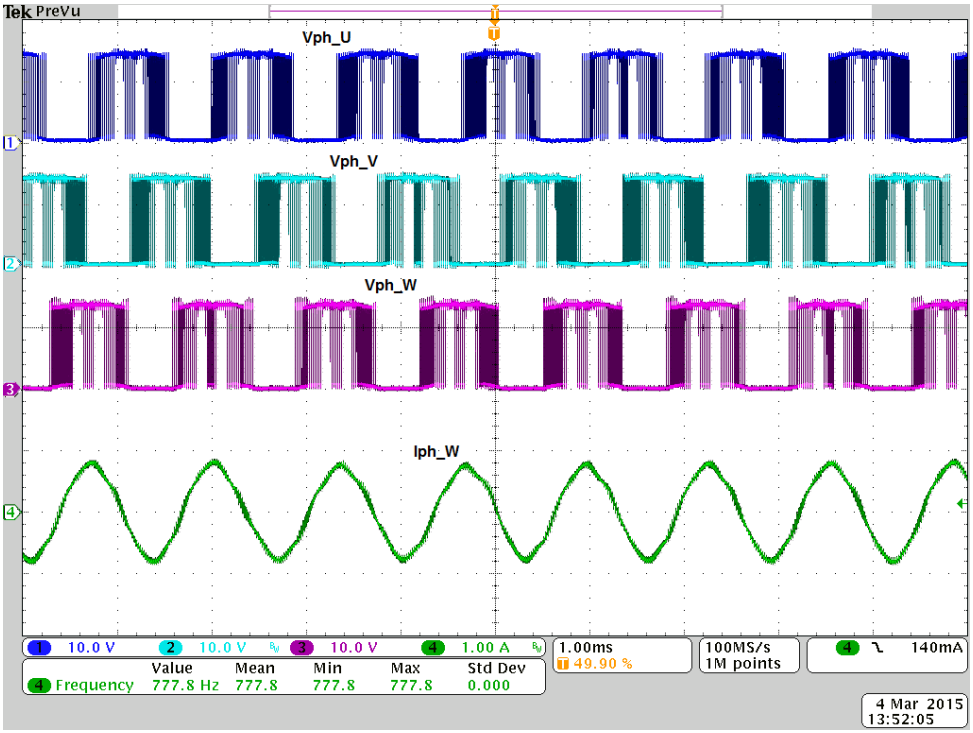


Figure 6: Motor Phase voltage and current at maximum 14V 23334RPM

**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.

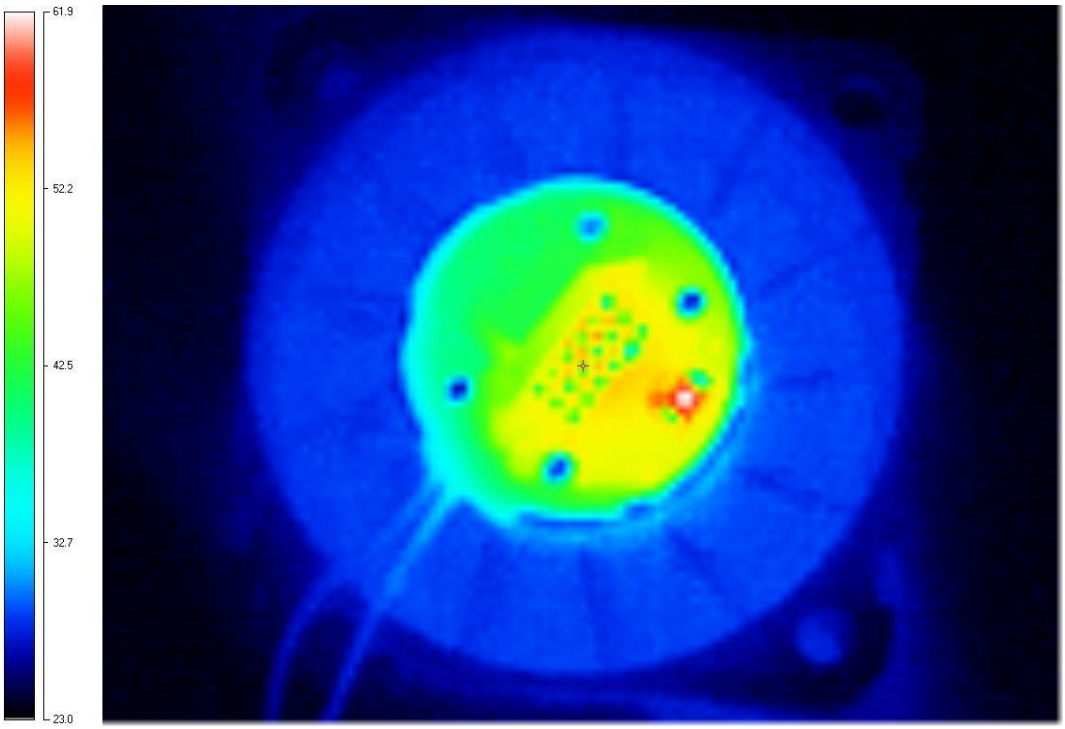


Figure 7: PCB top side thermal image at 12V 20196RPM

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