Technical Article

Cut the Power and Complexity of Your Appliance Designs

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Various applications use electric motors to improve our day-to-day lives, including household appliances, power tools and many automotive applications. The power required for motors in major home and small appliances – like refrigerator circulation and compressor fans, washing machine drain and water pumps, air purifiers, and pedestal fans (as shown in Figure 1) – can range up to 80W, whereas for other industrial applications the power can vary from as low as 5 watts to kilowatts.

Figure 1. Typical Home Appliances

Historically, these home appliances used single-phase AC induction motors. With the development of motors with permanent magnets, many companies are now able to develop and produce three-phase brushless DC (BLDC) motors with small sizes to support the same torque levels as single-induction motors. Although BLDC motors are physically and mechanically complicated, they are more efficient, quiet and provide flexibility for system design. In this post, I'll provide some insight into how TI's motor drive technology simplifies motor systems and helps achieve high efficiency, ultra-quiet operation and system reliability.

Figure 2 illustrates the power efficiency for each motor type under the same load conditions, collecting data using motors with less than 100 Watts. You can clearly see that for low power (less than 100W), three-phase

BLDC motors provide high efficiency. In addition, BLDC motors have long life and very low electric noise due to the lack of brushes, making them reliable for various applications such as appliances.

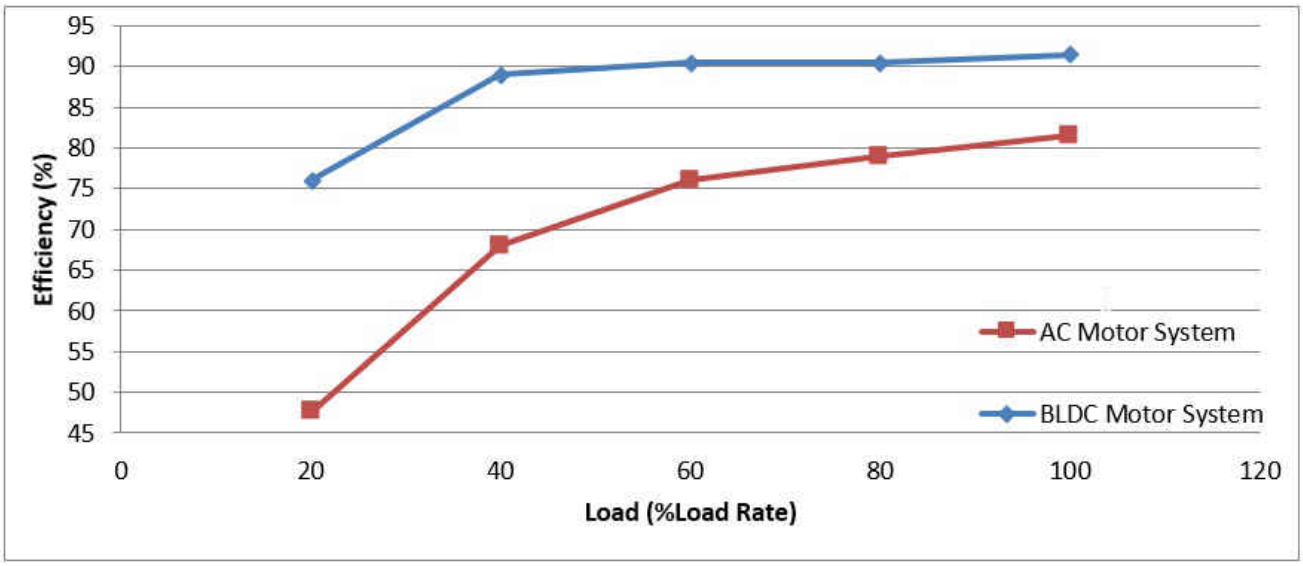

Figure 2. Efficiency Comparison

Each geographic region has different power outlet ratings for different applications, which stipulate the power and frequency for single-phase AC induction motors. For example, the U.S. requires AC lines that are 120VAC with 60Hz; Europe requires a 230VAC line with 50Hz. This is important, as designers must use different single-phase AC motors to adapt to regional output power requirements, which can complicate the circuit design. Single-phase AC induction motors that directly connect to the AC line do not give users the flexibility to control the motor speed. Furthermore, they generate intensive electrical and mechanical noise during operation.

Three-phase BLDC motors require additional circuitry to drive and control the motor, and it can be difficult and overwhelming for less experienced designers to move from single-phase AC induction motors to three-phase BLDC motor systems due to design complexity. However, TI motor drivers make this transition easier from single-phase AC induction motors to three-phase BLDCs. For an in-depth tutorial on moving from single-phase to three-phase BLDC motors, this white paper explains more on energy reduction.

TI's integrated motor driver portfolio integrates control logic, gate drivers and field-effect transistors (FETs) in one single package, enabling engineers to design simple and cost-effective motor control. The DRV10987 achieves high efficiency and ultra-quiet performance with TI's proprietary 180-degree sensorless sinusoidal algorithm. This integrated solution has products to support both 12V and 24V bus voltages. These are common voltages for appliance applications.

For example, the DRV10987 is a good fit for 24V systems and has adjustable slew rate and output pulse-width modulation (PWM) frequency for electromagnetic interference (EMI) management, which helps eliminate the external circuitry required for filtering EMI and reduces overall bill-of-materials (BOM) cost and printed circuit board (PCB) board space.

In addition to the complete portfolio of intelligent motor drivers, TI also has fully tested reference designs for washers/dryers, refrigerators, air purifiers, humidifiers and residential fans. These reference designs have test data, source files and design guides ready to help you develop and simplify the design for your products, enabling quick time to market. For example, the 24V, 50W BLDC Motor Sinusoidal Drive Reference Design for Air Purifier Fans is based on the three-phase sinusoidal DRV10983.

Table 1 summarizes the advantages of using three-phase BLDC vs. single-phase AC induction motor systems.

Table 1. Comparison between BLDC and AC Motor System for Appliances

	Single-phase AC induction motor system	Three-phase BLDC motor system
Power (W)	Fixed power	~40% power savings
Acoustics (dB)	Generates noise	Ultra-low acoustics (~10dB less noise)
Speed control (Hz)	Fixed speed	Variable speed
Size	Big size	Small size (up to 5x smaller)
Input voltage (V)	Fixed voltage	Flexible voltage operation

TI integrated motor drive products are facilitating the transition for engineers to design much simpler and smaller three-phase brushless DC systems for low-power appliance applications. This evolution helps drive power consumption for these appliances lower, while maintaining high efficiency and quiet operation. .

Additional Resources

- Read our blog series on optimizing designs with integrated BLDC motor drivers.
- Brush up on the latest motor design considerations for appliances.
- Consider purchasing the DRV10987 evaluation module.

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