

# Silence, Efficiency, and Intelligence in the Modern Home

Optimizing Residential Appliance Pumps and Fans with the  
Allegro A89347G

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# Introduction

Modern homeowners demand more from their appliances than ever before. Washing machines, dishwashers, ovens, and air purifiers are expected to operate silently, consume less energy, and integrate seamlessly into the "Smart Home" ecosystem. For design engineers, the challenge lies in delivering these high-performance attributes without increasing system complexity or manufacturing costs. The Allegro A89347G, a fully integrated, sensorless, sinusoidal BLDC motor driver, provides a robust solution specifically engineered to meet the demands of residential fans and pumps.

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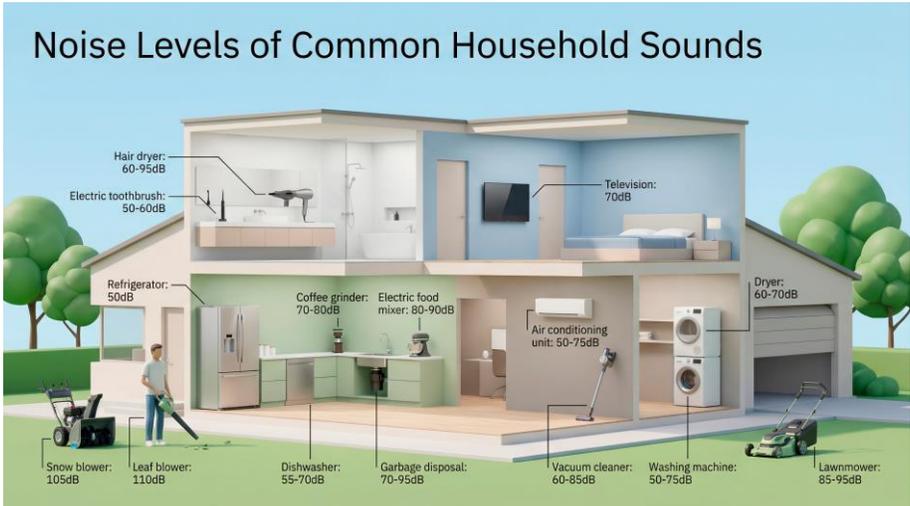
# The Challenge: Engineering the Unseen Components

In the competitive landscape of large home appliances, it's often the unseen components that define the user experience. While consumers focus on the main functions—the spin of a washing machine or the cooling power of a refrigerator—their satisfaction is heavily influenced by the performance of smaller, auxiliary motors. These "hidden" motors, driving everything from drain pumps to convection fans, present a unique and demanding set of engineering challenges that directly impact brand perception and product reliability.



## Acoustic Noise as a System-Level Constraint

Modern appliances are increasingly deployed in open-plan living environments, where acoustic emissions are far more noticeable. As a result, low operational noise has become a baseline expectation for modern appliances. In many designs, auxiliary motors are a dominant contributor to residual noise. Low-cost AC induction motors and block-commutated (trapezoidal) BLDC motors commonly used in pumps and fans can introduce torque ripple, vibration, and audible tonal components during operation. These effects can compromise the perceived effectiveness of “silent” or low-noise operating modes, even when the primary drive system performs as intended.



Data from: INAD, Common Noise Levels, <https://noiseawareness.org/info-center/common-noise-levels/>, accessed January 2026

## Reliability in Harsh Operating Conditions

Auxiliary motors are often required to function in the most challenging environments within an appliance. Drain pumps must tolerate particulate contamination such as lint, sand, or small foreign objects without jamming or excessive wear. Convection fans are subjected to prolonged high-temperature operation, thermal cycling, and grease contamination, all of which can accelerate bearing degradation and insulation aging. Failures in these subsystems frequently result in service interventions, secondary damage (e.g., water leakage), and disproportionate impact on overall product reliability metrics. From an OEM perspective, these components are expected to meet service-life targets with minimal field failure rates.



## Constraints on Space, Cost, and Complexity

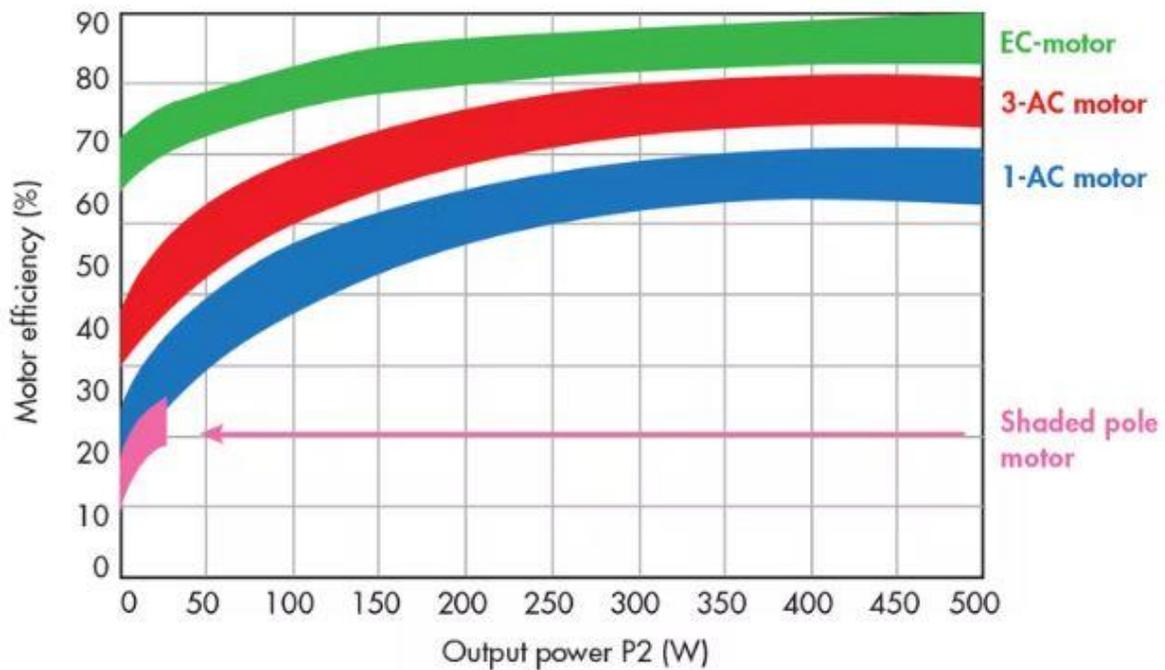
Modern appliance architectures must maximize functional volume and energy efficiency within fixed footprints, pushing auxiliary subsystems to be smaller and more cost-effective. Today's BLDC pumps and fans achieve superior acoustic and efficiency performance using sensorless commutation (e.g., back-EMF and sinusoidal control), eliminating rotor sensors entirely. This reduces BOM, wiring, and assembly complexity, while improving reliability in high-vibration, wet pump environments, and elevated oven temperatures. As a result, designers can meet performance and robustness targets without the historic trade-offs associated with sensor-based systems.



# The Shift to BLDC: Why Modern Appliances are Changing

Traditionally, auxiliary functions in appliances were powered by simple AC induction motors or brushed DC motors. The transition to Brushless DC (BLDC) motors is driven by four critical benefits:

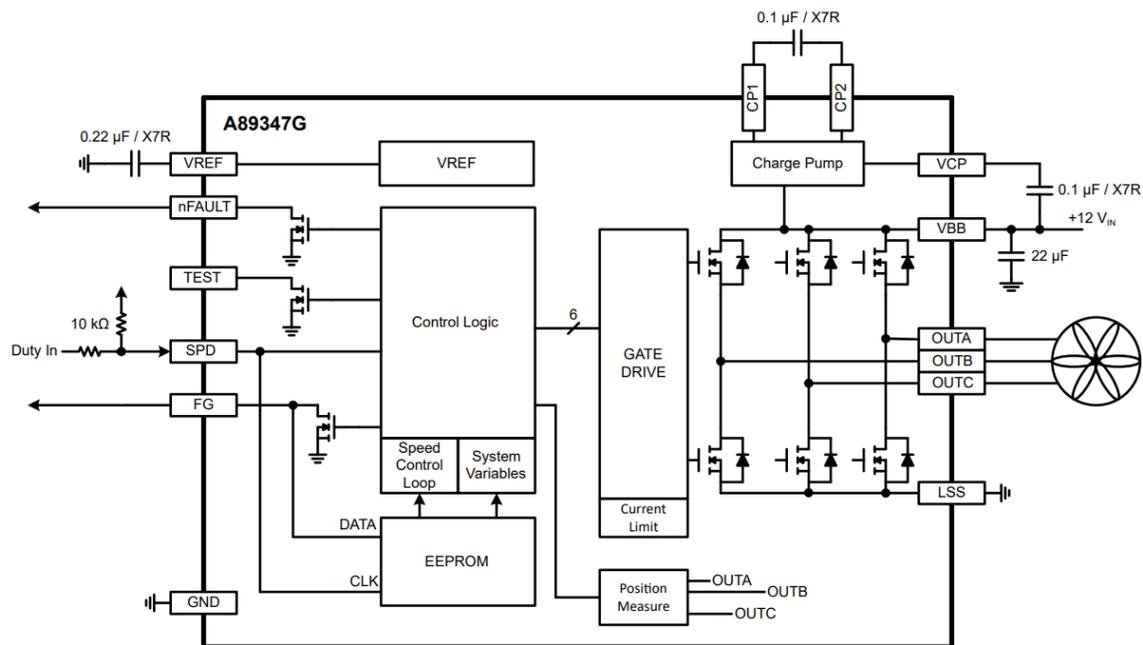
- **Superior Energy Efficiency:** BLDC motors are significantly more efficient (85-90%) compared to small AC induction motors (30-40%).
- **Precision Controllability:** Variable speed control allows dynamic adjustment based on load or environmental conditions.
- **Enhanced Reliability:** Eliminating mechanical brushes extends the lifespan to the 10+ years expected of major appliances.
- **Compact Power Density:** Higher torque-to-weight ratios allow for smaller motors and more internal appliance volume.



# The Solution: A89347G – The "All-in-One" Integrated Driver

To meet the tight space constraints and reliability demands of modern appliances, the A89347G delivers an industry-leading level of physical integration.

- **Tiny Footprint:** By integrating the control logic, charge pump, and power stage (MOSFETs) into a single 5mm x 5mm QFN or 20-lead TSSOP package, the entire drive circuit fits on a PCB small enough to be mounted inside the motor housing.
- **Integrated Sensorless Control:** Built in sensorless commutation (back-EMF/sinusoidal) delivers ultra-quiet, highly efficient operation while reducing BOM and wiring complexity. This approach enhances long-term reliability in wet, high-vibration pump housings and elevated oven temperatures, and supports closed-loop speed control with EEPROM-configurable startup and lock-retry behavior.
- **Simplified Architecture:** This high level of integration—combining power, logic, and sensorless control—replaces bulky discrete components and allows manufacturers to move from centralized control boards with heavy wiring harnesses to a distributed architecture where "smart motor modules" are connected simply by power and command lines.
- **Power Density:** Despite its size, it features an upper voltage limit of 40V and drives loads up to 30W with a peak current of 3.6A, making it capable of handling everything from refrigerator fans to washing machine drain pumps.



## Application Focus: Large Residential Appliances

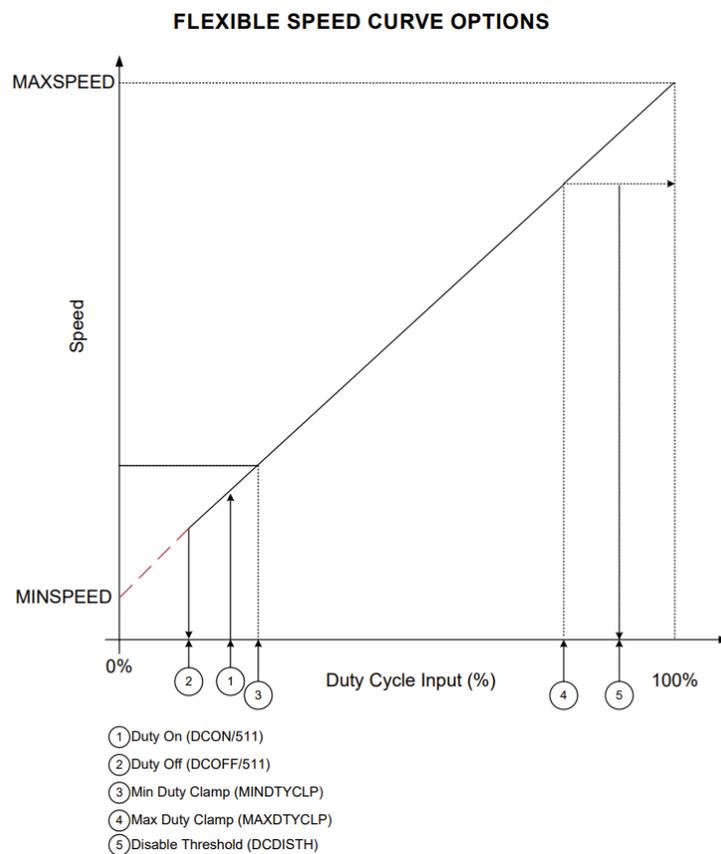
- **Washing Machine Drain Pumps:** The A89347G's robust startup and lock detection logic allows it to handle debris and jams, protecting the motor and ensuring cycle completion.

- **Oven Convection Fans:** The sinusoidal drive algorithm minimizes audible hum for quiet oven operation; the compact QFN and TSSOP packages with integrated sensorless commutation reduce BOM costs and wiring, enabling the driver to fit inside space constrained fan housings.
- **Refrigerator Circulation Fans:** Closed-loop speed control ensures consistent cooling airflow regardless of voltage fluctuations or back-pressure.

## Key Technical Advantages

- **Code-Free Deployment:** Accelerating Time-to-Market: Traditionally, implementing a quiet and efficient BLDC motor driver required a dedicated microcontroller (MCU) and a team of software engineers to write, test, and validate thousands of lines of firmware. This process is typically time consuming and adds significant project overhead.

The A89347G directly addresses this challenge. By integrating the basic closed-loop speed control function directly on-chip, it eliminates the cost, PCB space, and programming requirements of a custom MCU.

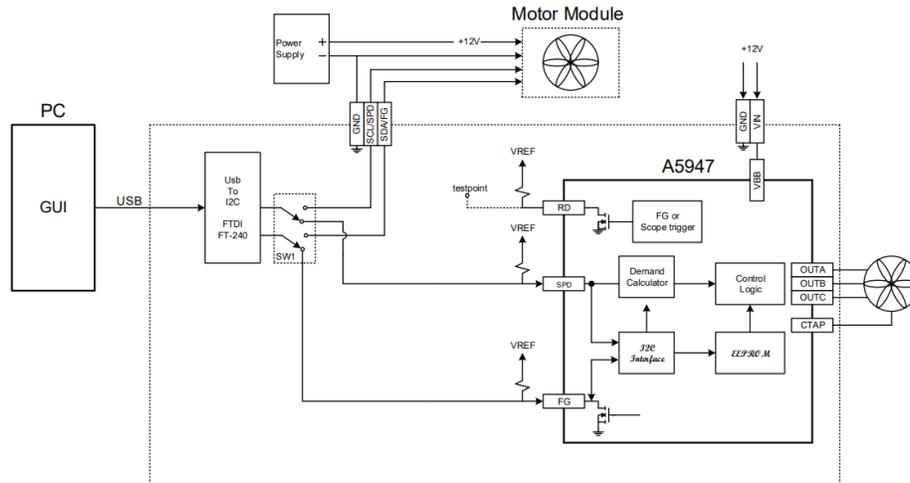


This is achieved through a simple, intuitive workflow:

- **Characterize:** Engineers connect their motor to an A89347G evaluation board and use Allegro's user-friendly GUI (Graphical User Interface) to tune performance in real-time.
- **Configure:** They define the complete operational profile—including the startup ramp, closed-loop speed curve, and protection thresholds—by adjusting parameters in the software.
- **Program:** Once optimized, these parameters are saved directly to the A89347G's on-chip EEPROM memory.

The result is a true "plug-and-play" solution. The device is now a pre-programmed, intelligent motor controller that operates autonomously, freeing up valuable engineering resources and drastically reducing the time from design to production.

- **System Efficiency:** Sinusoidal modulation, flexible closed-loop speed control, low-power standby mode, and lock-detect with configurable retry reduce wasted energy during stalls and transients.



## Enabling Smart Appliances: Connectivity & Diagnostics

In the era of IoT-connected appliances, the A89347G serves as a critical data point for the central processor.

- **I2C Interface & Diagnostics:** The A89347G features an I2C serial port that allows the main appliance MCU to read status registers. Instead of a generic "Motor Error," the appliance can distinguish between a locked rotor (debris jam), overvoltage (supply issue), or thermal warning.
- **Predictive Maintenance & User Alerts:**
  - *Example:* If the A89347G reports repeated high-current events or lock retries on a drain pump, the smart washing machine can push a notification to the user's phone: "Drain filter may be clogged. Please clean to avoid cycle interruption."
- **Distributed Processing:** By handling the complex motor commutation locally, the A89347G frees up the main appliance processor to focus on connectivity, user interface, and AI wash algorithms.

I<sup>2</sup>C Control Registers

REG	Bits		Function	Description
165	[8:0]	r/w	Speed Demand Input	Duty (%) = code / 511
128	[8:0]	r	Duty applied	Actual demand to the motor windings
138	[7:0]	r	Die temp	Temp °C = 3 + (CODE – 133) / 2
144	[15:0]	r/w	Number of startup failures	Cleared by writing zero or powerup
145	[15:0]	r/w	Number of startup attempts	Cleared by writing zero or powerup
147	[9:0]		Fault Status	
	0	r	Low-side VDS A	
	1	r	Low-side VDS B	
	2	r	Low-side VDS C	
	3	r	High-side VDS A	
	4	r	High-side VDS B	
	5	r	High-side VDS C	
	6	r	TSD	
	7	r	Charge Pump UVLO	
	8	r	VBB UVLO	
	9	r	VBB Overvoltage	
148	[15:0]		Lock detect criteria	
	0	r	Switch Over Error	
	1	r	Too Slow	
	2	r	Too Fast	
	3	r	Out of Sync	
	4	r	Bad Acceleration	
	5	r	Windmill Error	
	6	r	Max Phase Advance	
	14:7		Unused	
	15	w	Clear	Write 1 to clear the latched faults

## Integrated Protection: Engineering for Longevity

Reliability is the cornerstone of brand reputation in the appliance market. The A89347G incorporates a sophisticated suite of protection features designed to ensure the motor drive survives the harsh electrical and mechanical realities of residential environments.

- Intelligent Overcurrent Protection (OCP):** The A89347G utilizes advanced VDS (Voltage Drain-to-Source) monitoring across all internal power MOSFETs to instantaneously detect short-circuit conditions—whether phase-to-phase, phase-to-ground, or phase-to-supply. Crucially, the fault response is configurable via the OCPOPT EEPROM bit. Designers can select between a latched shutdown (requiring a power cycle to reset) for safety-critical faults, or a timer-based recovery, allowing the system to automatically attempt a restart after a lockout period. This flexibility is vital for minimizing service calls due to transient faults.
- Configurable Overvoltage Protection (OVP):** Appliance power rails are often noisy, and motors can generate significant voltage spikes during deceleration (regenerative braking). The A89347G features a programmable OVP threshold, selectable via the VBBOV EEPROM bit for either 19V or 38V operation. This allows the same IC to be optimized for 12V or 24V platforms. Additionally, the overvoltage protection option bit allows engineers to define the behavior: the driver can either temporarily disable outputs until voltage normalizes or latch off completely to protect downstream components from sustained surge events.
- Lock Detect:** The A89347G's integrated lock detection system is a critical reliability feature engineered to protect the motor from burnout and enhance appliance longevity. It continuously monitors motor rotation and, upon detecting a stall, initiates a protective shutdown. The intelligence of this system lies in its EEPROM configurability, allowing engineers to define a "hiccup and retry" strategy with a programmable shutdown duration (tLOCK) and a specific number of restart attempts (RETRY). This is invaluable in residential pumps, where the driver can autonomously dislodge minor debris like lint by pulsing the motor, while preventing coil damage from hard jams caused by coins. For fans in ovens or refrigerators, this same logic provides a crucial safety layer against fire hazards from seized bearings and eliminates the loud, irritating buzzing of a stalled motor, improving the overall user experience even during a fault condition.
- Thermal Defense (TSD):** To prevent catastrophic failure during sustained overload or high-ambient conditions (such as in oven convection fans), the IC includes a robust Thermal Shutdown circuit. If the junction temperature exceeds 165°C (typical), the drive outputs are disabled to protect the silicon. The device features a 20°C hysteresis,

ensuring the driver remains off until it has cooled significantly. This prevents rapid thermal cycling that could degrade the die, ensuring the appliance can recover from temporary thermal stress without permanent damage.



# Conclusion

The Allegro A89347G is more than just a motor driver; it is a key enabler of the next generation of smart, silent, and efficient home appliances. Its high level of integration allows for compact, "smart motor" designs, while its digital connectivity provides the data needed for intelligent diagnostics—delivering the premium experience modern consumers expect.