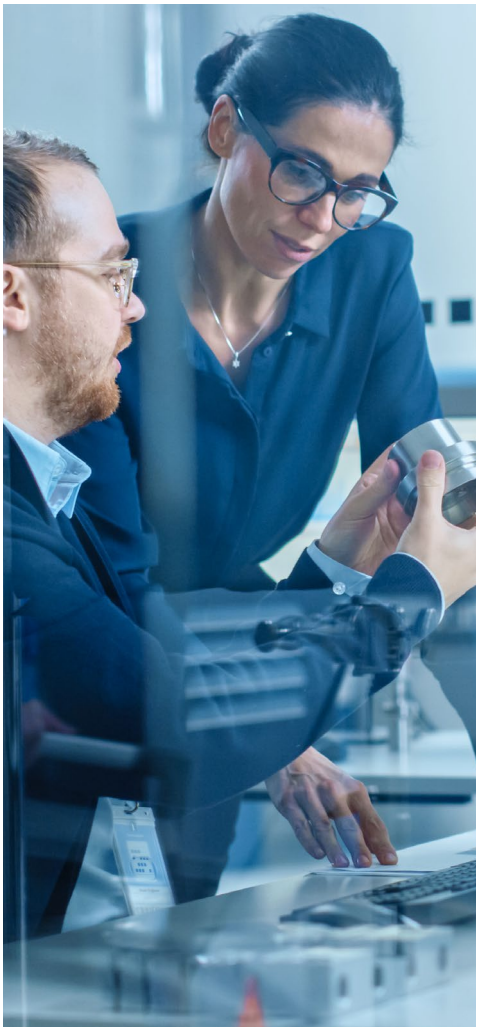
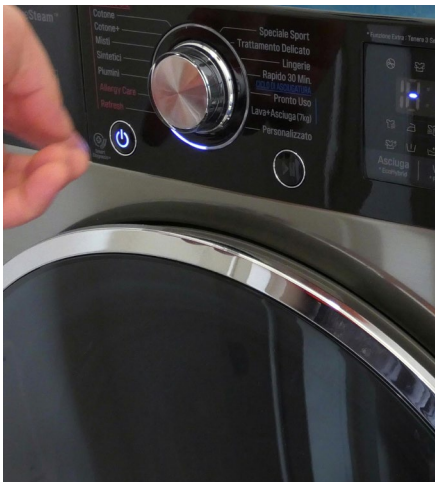
MARKET TRENDS IN WASHING MACHINE MOTOR DESIGN

As technology and consumer expectations evolve, washing machines are transforming into sophisticated appliances with advanced motors and control features designed to deliver convenience, efficiency, and sustainability. Examining these latest design trends is critical to commercial success, and so this article offers a look at the impact of motor technology, housing composites, shifts in wire material preferences and trends toward solderless connectors. Follow along as we explore these trends and combine them to offer robust solutions for washing machine motor designers.





MOTOR DESIGN TRENDS

Trend #1: Energy Efficiency Drives New Motor Technology

Increasing energy costs as well as energy efficiency legislation have driven washing machine manufacturers toward more efficient motors with higher initial costs. Mitigating climate change may also play a role. The following high-level comparisons of washing machine motor designs explore the advantages and disadvantages of each technology.

Universal Motors

Pros

- Low initial cost
- High starting torque, suitable for heavy loads
- Compact and lightweight

Cons

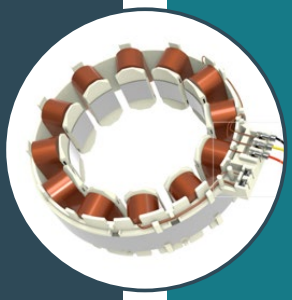
- Noise and vibration
- Less energy-efficient than other technologies
- Relatively shorter lifespan
- Frequent maintenance (due to brush wear)

Market drive towards high performance, high efficiency motors

Brushless DC (BLDC) Motors

Pros

- Highly energy-efficient
- Quiet
- Longer lifespan (no brushes)
- Variable speed control (optimized cycles)



Cons

- Higher initial cost
- Specialized electronics for control

Direct Drive Motors

Pros

- Extremely reliable and durable
- Energy-efficient
- Reduced noise and vibration (fewer moving parts)
- Precise control over drum movement

Cons

- Higher initial cost
- Repairs can be costly

Trend #2: Motor Housings Using Bulk Molding Compound (BMC)

Bulk molding compound (BMC) is a thermoset composite molding material with desirable properties for motor enclosures. Designers of washing machine motors are increasingly incorporating this material in new designs. It can be processed using compression, injection or transfer molding techniques. Some of the key benefits for motor designers are:

- Easily Formable: BMC is easily formed due to the melt fluidity of its resin. This makes it ideal for complex shapes.
- Dimensionally Stable: Products made with BMC have outstanding dimensional accuracy and are not susceptible to sink marks from the molding process. The surface finish can be extremely smooth which has both functional and aesthetic impact.
- Electrical & Thermal Performance: High dielectric strength and high resistivity (volume and surface) are typical with BMC resins. Their low thermal conductivity helps minimize undesirable heat transfer between electrical components. BMC can be engineered to have varying flammability ratings including some that can meet UL 94 V-0 requirements.
- Mechanical Durability: BMC can have good mechanical strength, stiffness, impact resistance and hardness. Typical formulations have good creep and fatigue resistance for sustained or cyclic loading respectively. Formulations for low coefficient for thermal expansion help prevent stress due to temperature variations. Excellent vibration damping characteristics make this compound quite attractive for encapsulating motors.

Trend #3: Lower Cost and Lower Weight with Aluminum Wire

Some motor manufacturers are shifting from copper magnet wire in motor windings to aluminum. Lower cost, lighter weight and reduced environmental impact drive this change. This shift comes with significant design challenges, including low wire conductivity and more difficult soldering or welding, but the benefits continue to drive adoption of aluminum magnet wire.

- Reduced Cost: Competition in the white goods industry requires cost-conscious design decisions. Due to lower conductivity, the required thickness of aluminum wire is higher, but this does not significantly offset the cost benefit over copper.
- Lower Weight: Aluminum wire is significantly lighter than copper which reduces the overall motor weight. Lower shipping and operating costs improve the environmental footprint as well.
- Sustainability: Aluminum is an abundant resource which takes less energy to mine, refine and recycle than copper. This makes it a popular choice to address the sustainability goals of manufacturers.

Trend #4: Cleaner Processing with Solderless Terminations

Soldering or welding terminations to motor magnet wire can be time-consuming, costly and difficult. This is particularly true for aluminum magnet wire systems. These connections can also be quite challenging to integrate into automated assembly operations.

Solderless terminals are being used to reduce manufacturing time and costs while facilitating the automation of washing machine motor assembly.

SOLUTIONS FOR THIS EVOLVING MARKET

TE Connectivity's Solderless Magnet Wire Terminals
TE Connectivity (TE) offers a full line of solderless solutions for copper and aluminum motor magnet wires. Our AMPLIVAR terminals and splices are excellent for lower production volumes where flexibility and speed are important. For high volume production, MAG-MATE terminals support a wide range of wire sizes and offer a variety of input types for customization. SIAMEZE terminals provide high-speed, compact terminations at low applied cost.

Key benefits of TE's solderless magnet wire terminals include:

- No Wire Stripping: TE's magnet wire solutions are available in crimp or insulation displacement contact (IDC) versions that both terminate without any wire stripping. The AMPLIVAR terminals feature a serrated crimp that pierces magnet wire insulation, while MAG-MATE terminals and SIAMEZE terminals feature IDC technology that removes the polymer wire coating during termination. These terminations deliver a clean, consistent and reliable metal-to-metal connection.
- Consistent Results: TE terminations are designed to be easily applied in either manual or automated processes. In both cases, the resulting connections are secure and reliable.

Current TE Solutions for Washing Machine Motors
AMPLIVAR Splice Solution: Magnet wires are positioned in the bottom of the AMPLIVAR splice before crimping. If a lead wire is included, it will be located on top of the magnet wires (Figure 1). The wire barrel connection includes internal serrations that penetrate the wire insulation layer and extrude the conductor surface when crimped (Figure 2). This maximizes the contact surface between the conductor and the termination while strengthening the joint. The AMPLIVAR terminal can be used to splice together multiple magnet wires or connect magnet wire to lead wire (Figure 3).

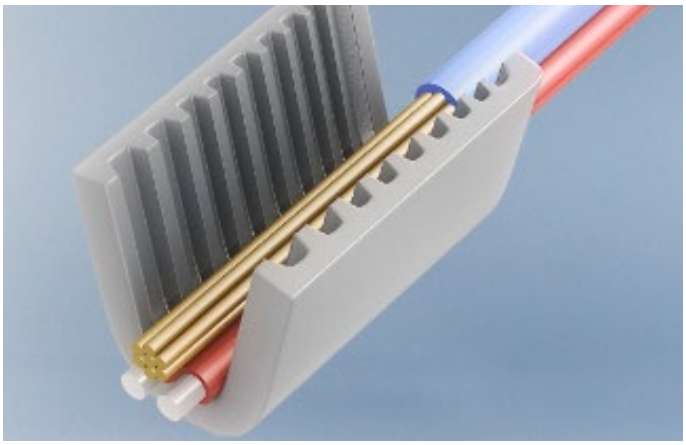


Figure 1: AMPLIVAR terminal configuration

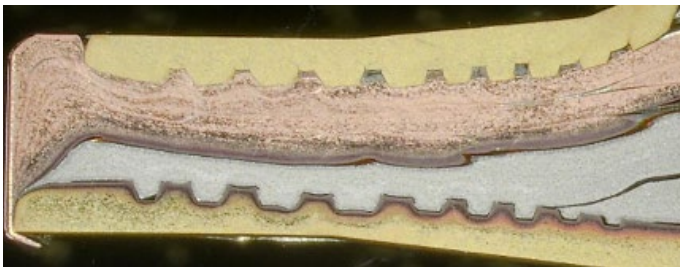


Figure 2: Serration penetration after crimping

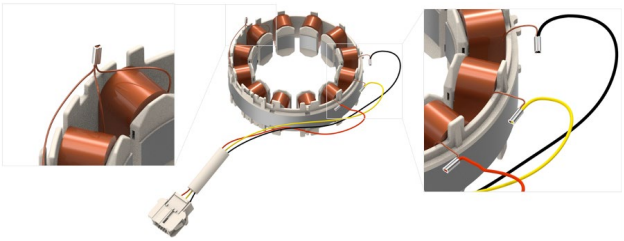


Figure 3: AMPLIVAR terminal application to motor windings

MAG-MATE Terminal Solution: Figure 4 details how MAG-MATE terminals achieve a solderless motor connection. These terminations have IDC (1) slots with stripping shoulders (2) at two points on each magnet wire. Once the magnet wire is positioned in the cavity slot (3), the terminal is inserted using the MAG-MATE terminal inserter which includes an insertion finger (4) and a trim blade (5). The stripping shoulders remove insulation during insertion and compress the bare wire in the slot, with the support anvil (6) holding it in place. This step also trims the wire & wire support block (7), providing a robust and reliable connection.

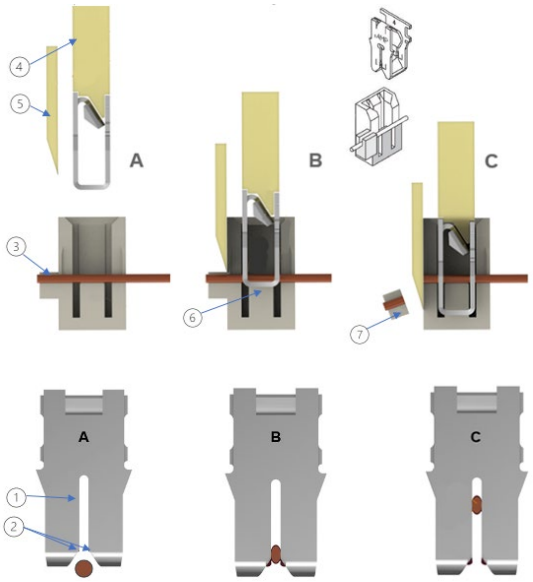


Figure 4: MAG-MATE terminal insertion

TE supports customized motor housings for MAG-MATE terminals by providing precise cavity specifications that can be incorporated into the motor design (Figure 5). These cavities can be formed using bulk molding compound (BMC) to realize the benefits of this thermoset composite resin. The MAG-MATE terminals are also available with a variety of lead wire input types (Figure 6) to acccommodate a range of design requirements.

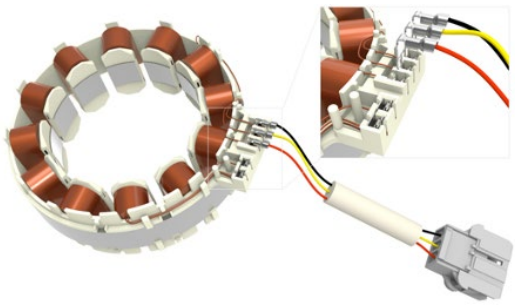


Figure 5: MAG-MATE terminal application with bulk molding compound (BMC) terminal housing

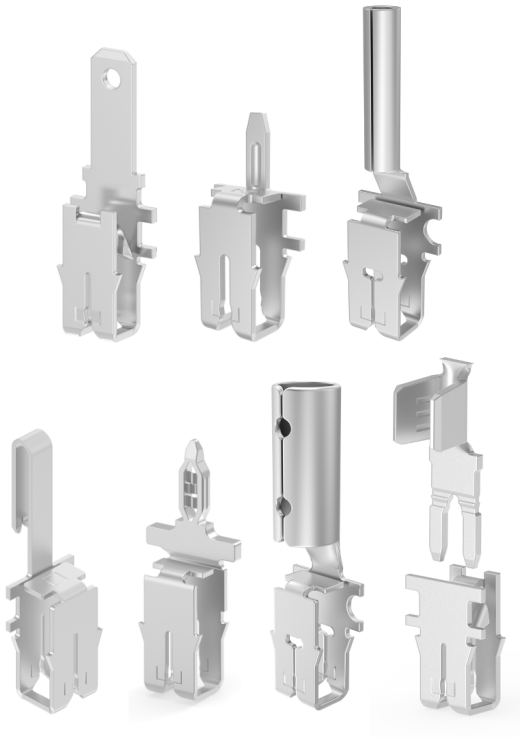


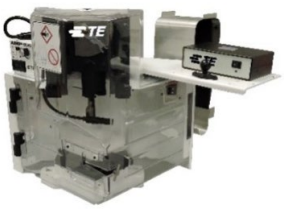
Figure 6: MAG-MATE terminal options

The Next Generation of Solderless Solutions

As washing machine technology continues to evolve, TE is developing new solderless solutions that offer added manufacturing benefits. These new offerings include compact SIAMEZE terminals and slim line MAG-MATE terminals, both of which help manufacturers save space while achieving applied cost reductions. Likewise, for manufacturers migrating from wire harness motor connections to direct-to-PCB systems, TE offers the MAG-MATE terminal with Multispring pin, which creates a secure, gas-tight and solderless connection between the PCB and magnet wire.

Application Tooling Solutions

TE offers a full line of wire termination machines from entry level, loose terminations to time-saving automated assembly line equipment. Whether you need hand tools, benchtop, or high volume terminators, TE has the right product. Contact your local distributor to discuss your unique needs.



FIND YOUR MOTOR CONNECTOR SOLUTION WITH TE CONNECTIVITY

TE Connectivity remains committed to developing and improving magnet wire solderless solutions for our manufacturing partners. Providing cost effective, sustainable connection solutions with automated assembly tools allows our customers to reduce labor costs while increasing productivity and minimizing human error. Our broad portfolio of magnet wire solutions and ability to support custom connector development let these solderless solutions fit in almost any electric motor system.

Contact our team to learn how our magnet wire solutions can help you.

CONNECT WITH US

We make it easy to connect with our experts and are ready to provide all the support you need.
Visit **www.te.com/support** to chat with a Product Information Specialist.

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Director Engineering

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Tim Ding
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