

# DESIGNING FOR TODAY'S CONNECTED APPLICATIONS

TE Connectivity Provides Insights on How to Solve  
for Today's Unique Design Requirements

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## WHAT DESIGNERS NEED TO KNOW ABOUT FOR DESIGNING TODAY'S CONNECTED APPLICATIONS

Today, consumers value the improved control, energy efficiency, reliability, and convenience of intelligent devices, influencing the trend of having high-end, connected applications that can communicate with the user, other applications and the cloud. The trend of quicker and smarter connectivity is posing as an opportunity for designers to leverage some of the reliable, proven products within the market.

A designer's project quickly becomes more complicated with the rapid evolution of connected technology. It begins with connected appliances that can communicate with the cloud to enable product usage analytics that enhance reliability and reduce service calls. Then add voice activation, remote control, environmental sensification, extensive electronification and other buzz-worthy technologies. At the home infrastructure level, additional smart technologies can be applied to manage heating, ventilation and air conditioning (HVAC) control, water, and energy without homeowner interaction. Considering all the evolving options, the designer faces the daunting challenge of integrating multiple signal, power, sensor, antenna, motor, and relay components while avoiding the hassles associated with technology "feature creep."

At TE Connectivity (TE), we are equipped with readily available global engineering expertise. Our teams rapidly work around the globe to understand the ins and outs of each subsystem design, including motors, pumps, heaters, control boards and power systems. TE has the global footprint and knowledge to understand how these subsystems work together across many different industries.

When designing for efficiency, reliability and connectivity, TE's experts have identified a few key areas for you to consider:

### Ergonomics

Connector assembly is a critical function in appliance manufacturing. Many connectors are used in power and control circuits of washers, driers, refrigerators, ovens, dishwashers, microwaves and

air-conditioning systems. In recent years, the task of connector assembly has become more complex. That's because advanced sensors, smart motors, electronic controls, and communication/networking capabilities are being used to make more intelligent appliances, which requires more connectors with different functionalities. Although robots and automation can be used for some connector-assembly tasks, many connectors are still assembled by hand. Proactively identifying ergonomic issues with features that improve a worker's productivity helps reduce human error, but also improves workplace efficiency and safety. By focusing on ergonomics — the science for optimizing the design and arrangement of the work environment — manufacturers can spot problem areas, implement best practices, increase task time on their production lines and select appropriate connector designs. The goal is to reduce human error in the factory and product repairs in the field.

Workers tend to make mistakes when they perform hours of repetitive motions during the assembly process of mating two connectors. Additionally, these repetitive motions may cause carpal tunnel syndrome (CTS), strained muscles and other physical injuries that impact workers' productivity, morale and health.

Key challenges that arise when connectors are assembled in the manufacturing workspace include:

- Inappropriately arranged workspaces that can cause repetitive strain injuries
- Terminals that may be not fully seated in the housing and connectors that are improperly mated resulting in production line and potential field failures

- High mating force required for some connectors that may lead to carpal tunnel injuries to production line workers, connectors not being fully mated, and latches not being fully engaged

Production line failures and high employee turnover directly impacts a company's bottom line and interrupt the flow of the manufacturing floor. Field failures can strain your relationships with their customers, impact brand reputation and, indirectly, decrease future revenue potentials.

Prevention is key to addressing these challenges and can be approached by focusing on using ergonomically friendly connector designs, creating a more ergonomic workspace, and increasing production line worker awareness of potential injury due to ergonomics.

By adapting tasks, work stations, and equipment, improving ergonomics seeks to reduce physical stress on a worker's body and minimize or eliminate serious work-related musculoskeletal disorders (MSDs).

A specific methodology should be employed to adjust the workplace to meet employees' ergonomic needs.

### Optimizing the Design Process

To begin at a day-to-day working level, designers will find it valuable to collaborate with partners who know how to connect multiple functionalities in devices all the way from wire to wire, wire to board, board to system, and system to networks. At a higher strategic level, a knowledgeable partner can proactively spot trends and suggest design options to help innovate features that provide a competitive

advantage and the appropriate products for custom applications. Voice of the Customer and Voice of the Industry insights are helpful for understanding current and future requirements. Those insights are a critical part of value-added engineering that can simplify the design process. An expert's perspective can also streamline the manufacturing workflow by considering high-speed progressive stamping, injection molding, various plating technologies, and automated assembly that can be optimized to meet manufacturing and product-design objectives.

**For general board-level and system design**, collaborating with experts is particularly important when facing tighter parameters for handling power and signals. Consumers prefer home automation devices to be as small and unobtrusive as possible. That means internal components need to be proportionally small, with further restrictions when additional functionality is packaged into those devices. For example, a single occupancy sensor may contain an ambient light sensor, a microphone, and other monitoring elements.

**For wire-to-board signal conduction**, the printed circuit board (PCB) of smart appliances tends to be crowded with more sensors and other electronics than in the past. Designers can accommodate more signal lines in less space with 2.5mm (0.098") centerline pitch and smaller pitch connectors. Designers also welcome the introduction of surface-mount options for 2.5mm and 2.0mm (0.079") connectors for PCB space savings and to avoid the added process cost of applying thru-hole connectors in a PCB with mainly surface-mount components. Other features include terminal position assurance (TPA) that ensures the contacts are properly seated in the housing while protecting against contact backout. Also important is low insertion force to facilitate assembly, while ensuring sufficient normal force for contact/connector performance and lanceless contacts to improve overall

### Insights from TE Experts - The Sensors, Terminals, and Antennas

#### You Need to Meet Your Connectivity Requirements:

- **Sensors** - the designer has a vast number of components that can be employed, such as:
  - Temperature sensors that can include negative temperature coefficient (NTC) thermistors, resistance temperature detectors (RTDs), thermocouples, and thermopiles
  - Humidity sensors available as assemblies, components, and PCB modules that are calibrated and amplified to measure relative humidity (RH), dew point, and absolute humidity
  - Air and water pressure sensors ranging from basic sensing elements to systems packaged for harsh environments configured either as board-level components or fully amplified and packaged transducers
- **Antennas** - standards are proliferating for Bluetooth, Wi-Fi, Zigbee, Z-wave, and other networks. Consequently, designers can work with a broad portfolio of standard and custom antenna technologies, including two shot molding, stamped metal, flexible printed circuit (FPC), PCB, and laser direct structuring (LDS) solutions, as well as embedded or multi-element external antenna options.
- **Motor subsystems** - the power and signal connector options mentioned above are relevant. Additional considerations include TE's AMPLIVAR terminals and splices especially designed for termination of copper and/or aluminum magnet wire, as well as TE's MAG-MATE terminals, which are insulation displacement crimp (IDC) terminals for magnet wire terminations. Available terminal styles include poke-in, poke-in tab, splice, crimp wire barrel, solder post, quick connect tab, pin and receptacle types.

Added into a designer's considerations are relays suitable for energy management systems, household appliances, HVAC controls, lighting, door controls, and home automation. PCB and panel mount relay configurations are offered for various current/voltage requirements.

Given the array of technologies that designers must consider when engineering more power efficient and intelligent appliances, collaborating with experts is critical to ensure products perform to the system design objectives.

contact retention.

**For power and signal wire-to-board connections**, examples of 2.5mm pitch board connectors are available for crimp termination as well as those that meet industry RAST standards for home appliances. Traditionally, RAST connectors are an insulation displacement connector (IDC) in which the terminal pierces the cable's insulation and makes secure contact with the conductor during assembly, which saves process time by eliminating cutting, stripping, and crimping individual contacts to the cable. Signal connectors are available in smaller pitch sizes accommodating termination of discrete wire, ribbon cable, and flexible printed circuits.

**For connecting power**, designers can also select larger pitch connectors for their size advantage and robustness. Power

connector product families offer the versatility of various wire-to-wire, wire-to-panel and wire-to-board configurations, including vertical or right-angle headers, plus a range of resins to meet UL and other industry standards. Larger pitch sizes are available to accommodate multiple circuit sizes and configurations, along with higher current and voltage ratings.

### The TE Advantage

TE is committed to meeting the needs of our customers. Not only does TE deliver products for current design specifications, but we also partner to identify new opportunities. We provide a comprehensive range of products across the industry, suitable for a wide variety of applications and end products. We are uniquely positioned to help you succeed and win in your unique design spaces.

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