

Effective Sensor Systems Depend on Well-Connected Cables



Ensure reliable sensor communications with these tips and best practices for proper cable and connector selection and installation.

When your machine design includes sensors in automated equipment, data centers, medical devices or process control systems, selecting the right device is just the first step. To achieve accurate performance, real-time transmission of sensor data and long operating life, a lot goes into finding the right sensor cable and connecting it properly.

Factors such as electrical requirements, durability and signal integrity are just some of the considerations designers must address to successfully meet their application requirements. This overview details important selection criteria and provides the best practices that specifiers and installers should follow.

Typical Challenges When Selecting Sensor Cables and Connectors

Choosing the wrong cable and connector can result in signal incompatibility or loss, electrical noise and downtime. These are often the unacceptable consequences for equipment that demands accurate data delivery and 24/7 operation. That's why it's important to select sensor cables with the following questions in mind:

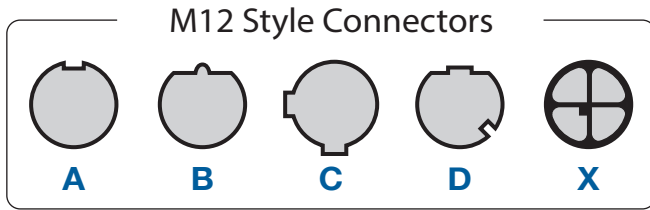
- **How many cables does the installation need?**

The number of cables the installation requires will depend on the sensor itself and its pin count, which is based on a connected component's function and the application's power and signal requirements. For example, applications involving high-speed data exchange will require more cables.

- **What is the correct connector style?**

Sensor pins are often configured to popular connector types such as M8 and M12, which have corresponding coding systems that specify appropriate pin counts.

A-coded connectors are the most common style for sensors, actuators and motors. A-coded M8 connectors are typically available in configurations ranging from three to eight pins, while A-coded M12 connectors can have two to 17 pins, with the three- to five-pin configurations being the most common for sensor applications. In addition, L, K and T



codes are higher-power, purpose-built A-code variants. L-coded connectors are particularly common in international markets and take up less space. Another style, C-code, is typically used with AC-powered devices, including sensors. D-coded connectors are used with Ethernet and Profinet networking cables to accommodate up to 100 Mbps. Increasingly popular X-coded connectors have eight pins and handle 10 Gigabit Ethernet (10 Gb/s). Coded cables have unique keyways that prevent them from being used in incorrect applications.

While 7/8-inch M8 and M12 are the most common connector configurations, more power-hungry applications typically require larger connectors. For example, the M23 size can handle up to 30A, and M40 connectors can support up to 60A. Both are metric-thread types appropriate for encoder feedback in servo systems and typically feature robust construction with metal housings and designated data pins.

▪ What are the power requirements?

Remember basics such as making sure the voltage rating satisfies the peak voltage requirement, and that the wire diameter can adequately handle the current without overheating. Also note that longer cables may require a longer conductor to maintain proper voltage on the sensor end of the run.

▪ How thick should the cable be?

For many industrial applications, 22 or 24 AWG is appropriate. While thinner cables are often used for shorter runs, they also have higher resistance. Therefore, longer runs require thicker cable to overcome voltage drops that can otherwise cause power insufficiency for the sensor as well as data errors. Thicker wires are also more durable, allowing them to withstand various physical conditions.

▪ What are the data transmission speed requirements, and which protocol is ideal?

Basic fieldbus cables are typically acceptable for low-speed sensor data transmission, while higher speeds require Ethernet cables such as Cat 5e (up to 1

Gbps), Cat 6, Cat 6a or Cat 8 (up to 10 Gbps). Also shield sensor cables to avoid electromagnetic interference (EMI) and ensure cable runs account for signal loss typical of high-speed data exchange over longer distances. When connecting distributed I/O or remote sensors to a central programmable logic controller (PLC), consider Profibus.

▪ What is the cable's bend radius?

Over-bending cables in tight panel spaces can compromise cable lifespan and signal integrity. This stress can damage internal conductors and insulation, leading to distorted signals and, ultimately, inaccurate sensor data. If space is tight, consider angled connectors that can avoid extreme bends and improve cable organization.



▪ What harsh conditions will the cable and assembly encounter?

As with any industrial or outdoor application, account for potentially damaging conditions. Common challenges include oil and chemicals, continuous movement, extreme temperatures and sunlight.

Material selection is important: choose polyvinyl chloride (PVC) for protection against moisture, water and sunlight in static applications, and polyurethane (PUR) for chemical and abrasion resistance and bending. Also, look for cables with high ingress protection (IP) if moisture and dust will be present. For connections, gold-plated contacts provide exceptional resistance to corrosion, moisture, dust and wear, ensuring greater reliability especially in signal processing and control panel installations.

Cable Installation: Tips and Best Practices

Proper installation is just as crucial to the cable's — and ultimately the sensor's — performance and reliability in its intended application. Here are just some of the details to remember to get the most out of your sensor connections.

- **Make sure the cables meet all the specifications.**

The previous section addressed questions concerning power, data exchange, signal integrity, environmental factors and both cable configuration and mechanical specifications. With these questions answered, implementers should be well on their way to a smooth installation and an easy-to-manage system.

- **Confirm cable and connector compatibility.**

The cable should match the connector type and its pin configuration.

- **Tighten connections.**

Loose connections create a long list of potential problems like overheating, arcing, mismatched impedances and susceptibility to damaging vibrations. Keep in mind, however, that over-tightening the connections may also lead to damage.

- **Comprehensive and visible marking.**

Clearly marked cables — on both ends — prevent misconnections and the associated electrical faults and equipment damage. Visible labels also make maintenance faster and easier.

- **Shielding/signal integrity.**

Use shielded cables to protect against interference that could disrupt data transmission and distort sensor information. This is especially important for applications with high data rates as well as those near motors and drives. Many Altech cables are available in shielded versions.

- **Use IP-rated cables and connectors in harsh environments.**

Depending on their intended environment, cables may be prone to incursion from dust, moisture, and chemicals and their consequences — including safety risks. Components with high ingress protection (IP) ratings offer greater peace of mind. For example, Altech sensor cable assemblies are rated to IP67, which indicates they are dust-tight and protected against the effects of temporary immersion in water.

- **Proper grounding.**

Don't forget to apply good grounding techniques.

An Ideal Vendor Provides Many Features and Options

When it comes to fast, accurate delivery of sensor data, there's no substitute for cables and connectors that cover your requirements and installation challenges. At Altech, we offer a wide range of standard cable products featuring durable PVC and PUR materials, robust nylon housings, standard lengths of one, two, five and 10 meters, and custom lengths if required. Altech cables are available in wire sizes from 22 to 26 AWG, and assemblies carry 30-, 60- and 250-V ratings.

We also have a comprehensive connector lineup that includes 7/8-inch thread A-coded M8 and M12 sizes with three, four, five, eight or 12 poles, male and female. B-coded units are also available for fieldbus applications. Metric-sized M23 and M40 connectors are also available, with M23 having 12, 15 and 19 pole counts, and M40 units with six, eight or nine positions. All Altech connectors are designed for easy identification.

Options include straight and angled types, overmolded cables, screw connections, solder terminals, dual connectors, bulkhead, panel feed-through and field-wired connections. Taken together, these options provide designers with tremendous flexibility to obtain an ideal assembly for their sensor-based systems.

Make sure your component manufacturer understands your specifications. If their standard products do not quite meet your requirements, look for a partner that offers customization options. At Altech, we have the materials and technical know-how to provide custom solutions and assemblies that meet the data specifications and environmental conditions that sensor-based systems demand in their intended applications. Most cables and connectors are manufactured in-house, and we stock a large selection of components at our facility. That means we deliver samples and prototypes promptly, and our quick production turnarounds help get systems up and running fast. Be sure to get in touch with us early in the specification process.

Achieve an Optimally Performing Sensor System

Specifying and installing a sensor cable system presents many challenges and considerations. Work closely with your sensor cable and connector vendor, answer the important sensor cable selection questions and follow best practices for installation. You'll achieve an optimally performing system that will reliably meet your application needs for years to come.

For more information, please visit our product page.

<https://altechcorp.com/91-sensor-actuator-cables-and-connectors>

ABSTRACT

When your machine design includes sensors in automated equipment, data centers, medical devices or process control systems, selecting the right device is just the first step. To achieve accurate performance, real-time transmission of sensor data and long operating life, a lot goes into finding the right sensor cable and connecting it properly. Factors such as electrical requirements, durability and signal integrity are just some of the considerations designers need to address to successfully meet their application requirements. This article will provide an overview of important selection criteria along with the best practices specifiers and installers should follow.