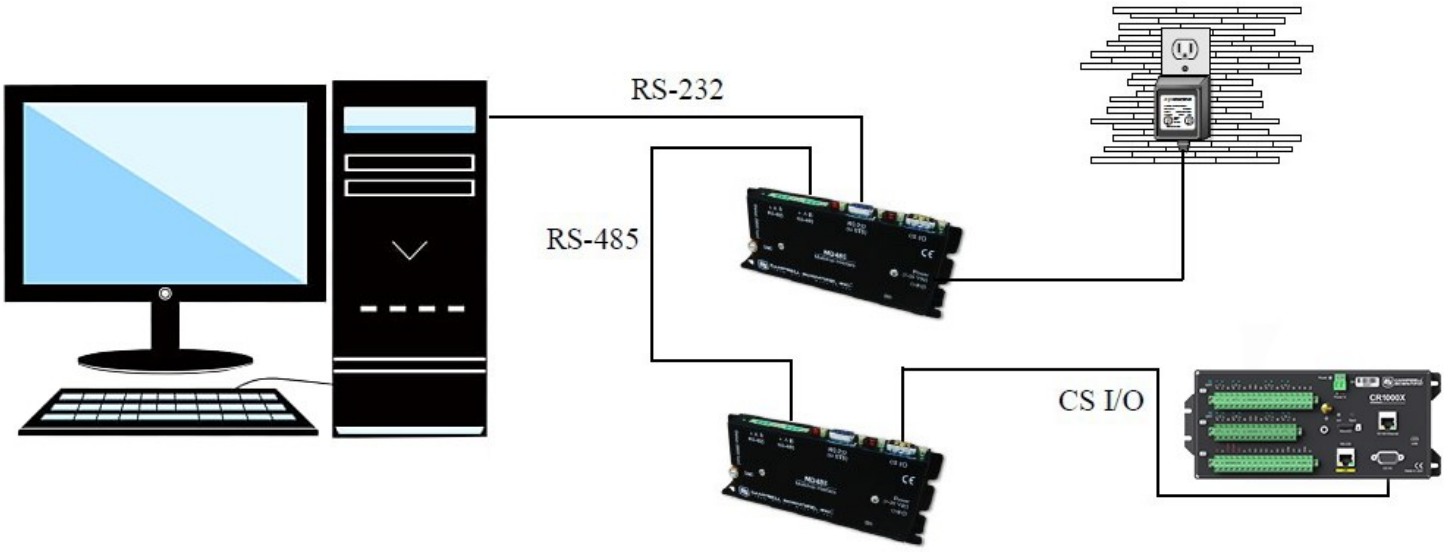
APPLICATION NOTE

Communications Device

Maximum Distances for RS-232 and RS-485



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1. Introduction

RS-232 and RS-485 are two commonly used standards for serial communications in various applications, including industrial automation, data acquisition, and telecommunications. Understanding the maximum distances for these communications standards is essential for designing reliable systems.

> NOTE:
> This document focuses on communications between devices rather than the length of RS-485 and RS-232 sensor cables. Since RS-485 and RS-232 sensors may have different specifications and guidelines due to variations in power, drivers, and application constraints, the recommended cable lengths should be determined based on the individual sensor's specifications.

2. RS-232 communications

RS-232 (Recommended Standard 232) is a serial communications standard commonly used for point-to-point connections. It is widely recognized for its simplicity and ease of implementation.

2.1 Maximum distance

The maximum cable length for RS-232 communications is typically limited to **50 feet (15 meters)** at 19200 baud. However, the effective distance can vary based on several factors, including:

- **Baud rate:** Higher baud rates may result in shorter transmission distances due to signal degradation.
- **Cable quality:** The type of cable and its shielding can affect performance.
- **Environmental conditions:** Electrical noise and interference can impact signal integrity over longer distances.

2.2 Advantages

RS-232 is widely recognized for its simplicity and ease of implementation. It the simplest and most common method of signal transmission.

2.3 Limitations

- **Limited connections:** RS-232 is limited to point-to-point configurations, meaning it can connect only two devices directly.
- **Single-ended line configuration:** This means only one wire carries the signal information, with the other wire typically connected to ground. This single-ended configurations is more susceptible to noise compared to differential signaling, which uses two wires carrying complementary signals.
- **Noise and signal attenuation:** Signal levels are susceptible to attenuation and noise over longer distances, leading to potential data corruption.

2.4 RS-232 data cable recommendations

For standard applications (up to 50 feet [15 meters]), 24 to 26 AWG is typically sufficient. For longer distances, shielded cables with lower resistance (22 to 24 AWG) may help maintain signal integrity. Shielding is also recommended to reduce interference.

3. RS-485 communications

RS-485 (Recommended Standard 485) is a differential serial communications standard designed for multipoint applications. It allows multiple devices to communicate on a single network, making it ideal for industrial and automation systems. The EIA/TIA RS-485 communications standard supports 32 devices (driver/receiver pairs).

3.1 Maximum distance

RS-485 can achieve much longer distances than RS-232, with a maximum cable length of **4,000 feet (1,200 meters)** at lower baud rates (e.g., 9600 baud). However, the distance can decrease at higher baud rates:

- Up to **1,200 feet (400 meters)** at baud rates of **115.2 kbps**.
- Up to **400 feet (120 meters)** at baud rates of **1 Mbps**.

3.2 Advantages

- **Minimizes noise and interference:** RS-485's differential signaling helps minimize the effects of noise and interference, allowing for reliable communications over long distances.
- **Supports multiple devices:** RS-485 supports multipoint configurations, enabling up to 32 devices on a single bus.

3.3 Limitations

While RS-485 is robust, the maximum distance can be affected by factors such as:

- **Cable type:** Twisted pair cables are required, and shielded cables are recommended to enhance noise immunity. Readily available Ethernet cables, such as Cat5 can be used. See RS-485 data cable recommendations (p. 3).
- **Termination:** Proper termination resistors are required to prevent signal reflections.
- **Network topology:** Star configurations can lead to signal integrity issues; a daisy-chain topology is preferred.

3.4 RS-485 data cable recommendations

- Twisted-pair cable is required.
- Shielded cable is recommended. Connect the shield ground at only one end.
- Common cables, such as Cat5, work for short distances.
- The maximum RS-485 rated distance of 4,000 ft can only be achieved with cables specifically designed for RS-485. Major suppliers, such as Belden and Alpha Wire, offer part numbers designed for RS-485 data buses. RS-485 cables have an impedance of 120 Ω, while Cat5 cables have an impedance of 100 Ω.
- The typical wire gauge is 22 AWG or 24 AWG. Special 18 AWG cables are available for locations requiring more robust 600 V insulation. Higher-gauge wires may require lowering the baud rate for reliable communications.

4. Conclusion

When designing a communications system, it is crucial to consider the limitations and maximum distances of RS-232 and RS-485 standards. RS-232 is suitable for short-distance, point-to-point communications, while RS-485 is ideal for long-distance, multipoint applications. By adhering to these guidelines, users can optimize their serial communications systems for performance and reliability.

5. Additional resources

Additional information is available at the following websites:

- Fundamentals of RS-232 Communications
- The RS-485 Design Guide

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