HOW TO AVOID POLARITY ISSUES AND OPTIMIZE YOUR BUILDING AUTOMATION SYSTEM

RS485 is a widely used communication standard in building automation systems like Modbus RTU or BACnet MS/TP, that uses a differential balanced line consisting of two wires, positive and negative, to transmit data. However, device manufacturers may label the terminals differently, leading to polarity issues that can cause communication failures.
This happens because there is no strict standard for polarity labeling. While the RS485 standard specifies that the negative and positive terminals should be labeled as A and B, respectively, some manufacturers may use different labels such as + and-, D+ and D-, or A and B with reversed polarity. This can cause confusion for users who assume that all devices will follow the RS485 standard labeling convention.
This application note delves into the common occurrence of polarity issues in RS485 networks and provides insights on Intesis' approach to defining and managing polarity in such networks. The aim is to help integrators prevent future issues from occurring.

RS485 NETWORKS

In RS485 networks the polarity of the wires is critical to ensure reliable communication. The RS-485 standard specifies a characteristic impedance of 120 Ω for the differential pair. While it is theoretically possible to connect up to 32 devices (more with an RS-485 repeater), the actual number of nodes that can be connected depends on the chosen communication speed, also known as the baud rate.

- **Communication speed (baud rate)**
  The communication speed has a direct impact on the number of nodes that can be connected and the maximum communication distance. As the speed increases, the number of nodes that can be connected decreases, and the maximum communication distance decreases as well. For instance, at a high-speed setting of 10 Mbps, RS-485 can only operate reliably over approximately 12 meters. On the other hand, if a lower speed of 100 kbps is selected, communication over up to 1200 meters can be achieved.
  It is important to consider the communication speed and distance when designing an RS-485 network to ensure reliable communication and avoid signal degradation.

- **Topology**
  When connecting devices using the RS-485 protocol, the most recommended layout type is a daisy chain topology. This means that devices are connected in a linear chain, where the output of one device is connected to the input of the next device, forming a continuous line. Other topologies such as Star, T-Drop, or Ring are not recommended for RS-485 networks. The reason for favoring the daisy chain layout is that RS-485 operates as a high-speed transmission line, and it is susceptible to signal reflections.

Polarity issues in RS485 Networks

Polarity definition

The voltage difference between the positive and negative wires determines the logic state of the signal on the bus. The voltage difference between the two wires is expected to be at least 0.2 volts.

- Binary “1” happens when the voltage on the positive wire is greater than the voltage on the negative wire.
- A binary “0” is the state where the voltage on the negative wire is greater than the voltage on the positive wire.
- Idle: when the difference between positive and negative wires is less than 0.2v.

RS485 is known for its polarity insensitivity as most devices can automatically identify the positive and negative wires in the differential balanced line. This is possible because, during the idle state, the positive wire maintains a slightly higher voltage than the negative wire.

Polarity issues

The RS485 standard specifies that the two terminals should be labeled A for negative and B for positive. However, device manufacturers may label the terminals differently, leading to confusion and incorrect connections. These differences in labeling can cause polarity issues and communication failures.

Furthermore, not all devices comply with the RS485 standard’s recommended voltage difference of 0.2V between the positive and negative wires during the idle state. Some devices may have different voltage requirements.

Intesis polarity in RS485 networks

Intesis RS485 labeling is as follows:

STANDARD	INTESIS	
RS485	**Europe/Asia/Latam**	**USA**
SGND	SGND	SGND
NEG	B-	A-
POS	A+	B+

Additionally, Intesis RS485 gateways feature built-in termination resistors, simplifying the setup process and ensuring reliable communication.

Recommendations to avoid the polarity issues:

- Read the manual carefully: It is essential to carefully read the manual and follow the manufacturer’s labeling instructions to ensure correct connections.
- Verify polarity with a multimeter: Users should verify the polarity with a multimeter during the idle state and ensure that the termination resistors are properly placed.
- Ensure proper termination resistors: Properly placed termination resistors are critical to ensuring reliable communication in RS485 networks.
- Run a common ground wire: Running a common ground wire to all devices and termination resistors can reduce the impact of electrical noise and grounding issues.
- If it doesn’t communicate, try inverting the polarity again.