FieldServer ENOTE

Serial Communication Issues

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1   Bias and Termination Resistors on an RS-485 Network

This document provides an explanation of why and how Bias and Termination resistors are used on a RS-485 network. Let's simplify the setup and see how these configurations are made using RS-485 devices.

We need a bit of theory here to understand why an RS-485 network needs Bias resistors and Termination resistors in the first place.

1.1   Termination Resistors

Transmission line effects often present a problem in data communication networks. These problems include reflections and signal attenuation.

When a voltage is first applied to an RS-485 line, current flows through the line (even if the line wires are open). Shortly after reaching the end of the line, the current settles to a final value determined by the series resistances in line, the voltage applied, and termination. The line sees reflected voltages as the current settles if the initial and final currents vary, resulting in possible data integrity issues.

If the data rate is low or cables are short, termination may be unnecessary. As data rates and/or cable lengths increase, which is most cases, termination becomes mandatory.

To eliminate the presence of reflections from the end of the cable, it must be terminated at both ends with a resistor across the line (between + and -), in accordance with its characteristic impedance. Both ends must be terminated since the direction of propagation is bidirectional.

In case of an RS-485 twisted pair cable this termination is typically between 120 and 130 Ω.

Here is a simple schematic of how the end of the lines should be terminated:
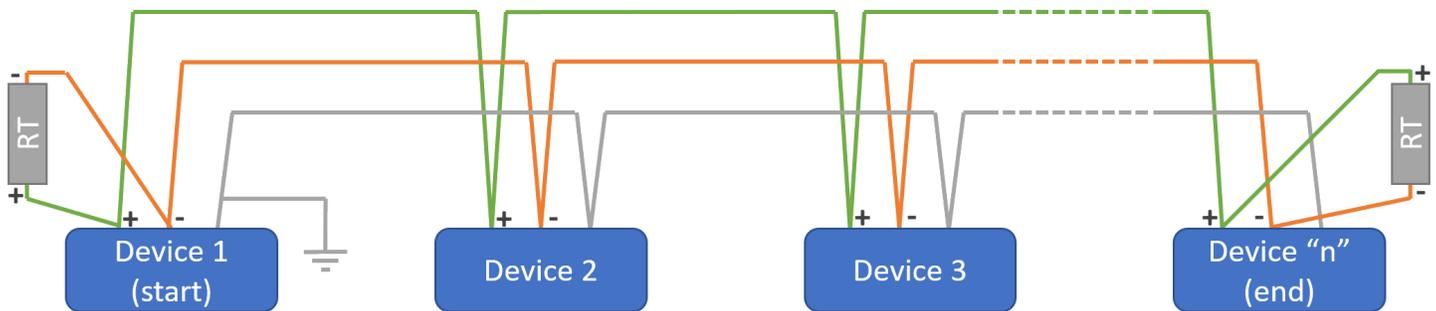
NOTE: "RT" is the 120 Ω termination resistor.

NOTE: "Device 1" on a Modbus network is the Master device initiating communication.
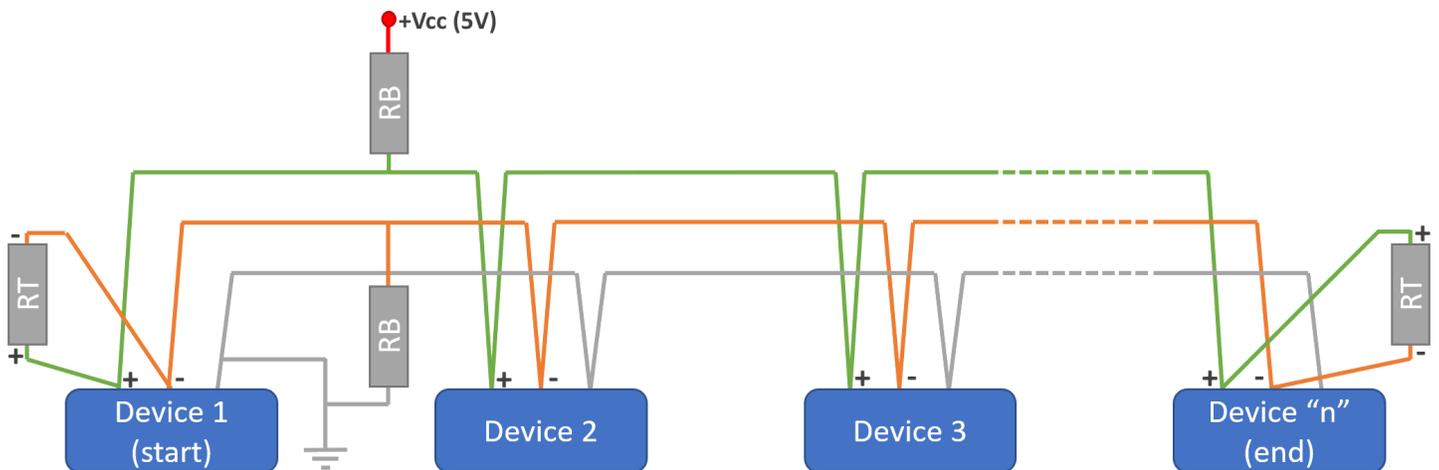
1.2   Bias Resistors

With RS-485 networks, there are periods of time when no driver is actively driving the bus. On a Master-Slave network this would correspond to potential times when the Master is not transmitting and the slaves have finished responding to any command.

This state is also called "tri-state mode".

During this time, the termination resistors collapse the differential bus voltage to 0V, which is an undefined input level for many RS-485 receivers. Faced with this undefined input, a receiver might output the wrong logic state or worse yet, it might oscillate. The oscillation may be interpreted as an endless stream of message start bits, causing the controller to waste valuable bandwidth trying to service these phantom messages. Fail-safe bus biasing is one way to alleviate this problem.

The objective of biasing is to make sure that the RS-485 line remains in a known, non-fluctuating state when no devices are transmitting. Biasing the entire network requires a single pair of resistors: a pull-up resistor to +5V attached to the "+" signal line, and a pull-down resistor to ground attached to the "-" signal line.

See the schematic here below which explains how biasing is achieved:

The "RB" going between "-" and "earth" is the "pull-down" resistor, the "RB" going between "+" and "+Vcc(5V)" is the "pull-up" resistor.

1.3 How to Setup Termination and Bias Resistors on a FieldServer

FieldServer units are provided with a set of dip-switches that allow configuration of the termination and bias without the need of physically connecting the resistors.

For legacy units there are 2 jumper switches for the R2 port and 2 dip switches for the R1 port:
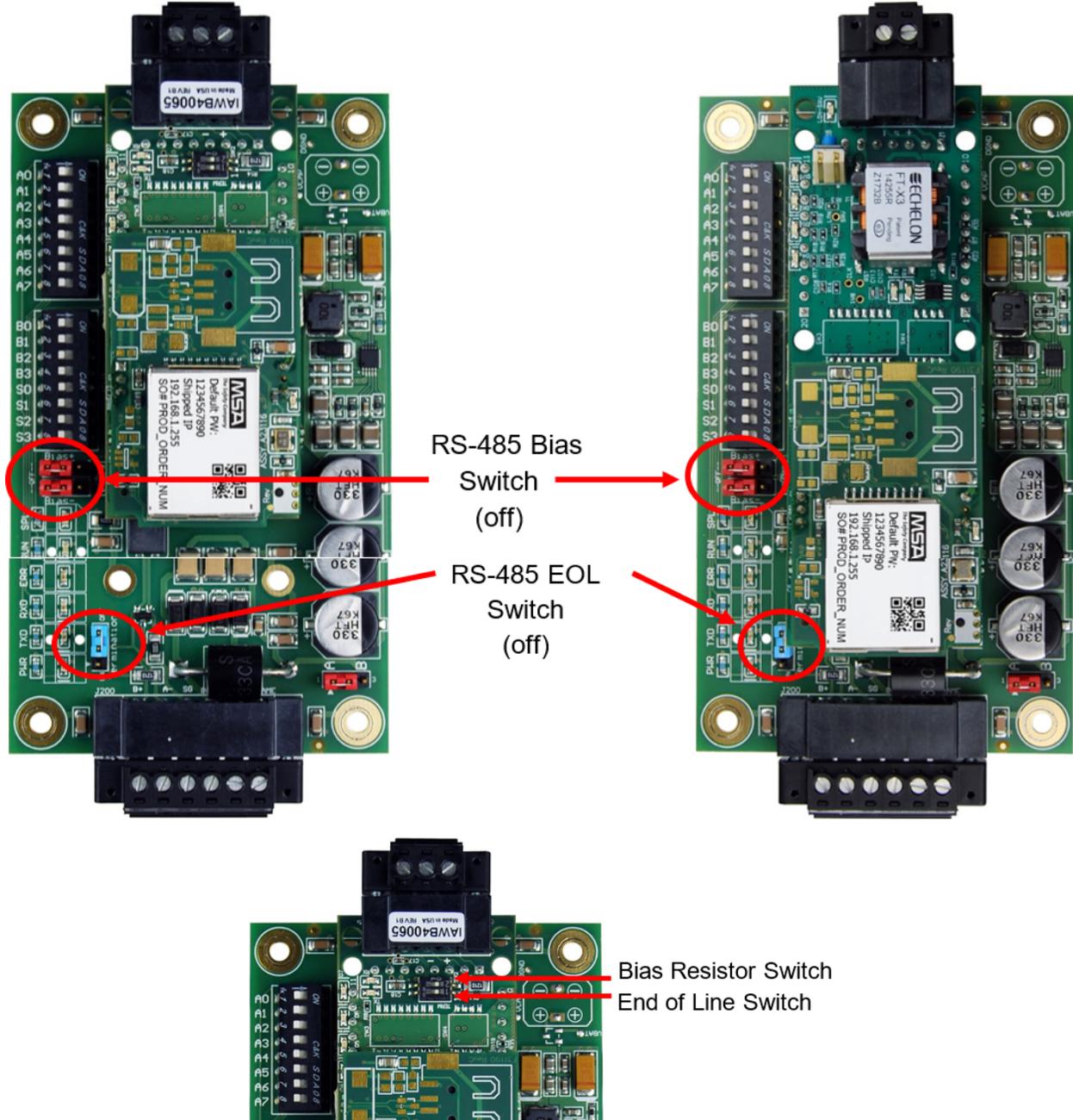
TERM - Set this dip-switch/jumper to "ON" if you want to enable the termination resistor, "OFF" if you want to disable it.

BIAS - Set this dip-switch/jumper to "ON" if you want to enable the the bias resistor, "OFF" if you want to disable it.

For modern units, there are a total of 4 dip-switches:

TERM - Set this dip-switch "ON" if you want to enable the termination resistor, "OFF" if you want to disable it.

BIAS+ - Together with BIAS-, these should both be "ON" if you want to enable the bias resistors. Both should be "OFF" if you want to disable the bias resistors.

BIAS- - Together with BIAS+, these should both be "ON" if you want to enable the bias resistors. Both should be "OFF" if you want to disable the bias resistors.

485/232 - If you are using a RS-485 network, this dip-switch should be left to the "OFF" position.