Cabling between iSCADA Gateways & Slaves

Communication between iSCADA gateway and slaves is on RS485, and it is recommended that a screen-twisted pair cable is used. This article discusses the principles of twisted pair cables and differential signals With some minor exceptions, twisted pairs are used when the signal transmitted by the cable is a Differential Signal.

What is a Differential Signal? What is a Differential Cable?

One of the key problems in transmitting data or any kind of computer type signal from one device to another is the electrical "noise" or Radio Frequency Interference (RFI) that penetrates the cable and gets mixed with the useful data or signal. The longer the cable, the more likely the RFI.

RFI, radio frequency waves that travel through the air, are intentionally and unintentionally generated by a wide variety of electrical equipment. These include TVs and radios, electrical motors, elevators, photocopiers, microwave ovens, fluorescent lights, all broadcast antennas, and all the communications equipment and computers themselves.

The first line of defense against RFI is to shield the cable with a conductive material that has been electrically grounded. However, even with the best shielding, cable length is quite limited. To overcome such limitations, equipment designers have turned to a technique of transmitting computer signal called the Differential system.

With the differential system each signal is transmitted on two lines at the same time. On one, the signal is transmitted as a positive (+) signal, on the other as a negative (-) signal. At the receiving end of the cable the receiver device gets two signals. Both of them however, have been changed by the noise that penetrated the cable. The changes came in the form of unwanted voltage added to the wanted signal. At this point it is important to note that the unwanted voltage got added to both lines at the same time and by the same amount. The essence of the Differential system is that the receiver is designed to take the difference between the two signals on the two lines. In doing that, the noise part of the signal, equal on both lines, gets eliminated, and what remains is clear signal.

As indicated above, the Differential system works well if the noise added is equal on the two lines, i.e. the POSITIVE (+) and the NEGATIVE (-). To ensure that the noise hits both of these lines identically, both of them need to occupy theoretically the same physical space. Practically, the closest we can get to this requirement is to have the two lines twisted together tightly. The tighter the twist of (+) and (-) lines the cleaner the transmission, and the longer the acceptable length of the cable.

In conclusion, a Differential Cable is a Twisted Pair cable between devices that use (+) and (-) values in transmitting their signals to another device. In some instances i.e., V.35, X.21, etc. the letters (A) and (B) are used to designate (+) and (-) respectively.

When MAKING a Differential Cable, always the (+) and the (-) sides of each signal are twisted together. For instance, to make the "Transmit Data" pair, TxD(+) can be twisted ONLY with TxD(-). Similarly, RxD(+) is twisted ONLY with RxD(-). When using alternate notations, TxD(A) is twisted together with TxD(B), TxC(A) with TxC(B (Transmit Clock), and so on. Not all signals used by a particular differential device are transmitted as a (+)/(-) pair. For instance, control signals like RTS (Request To Send), CTS (Clear To Send), DSR (Data Set Ready), etc., are transmitted in V.35 as (+) signals only. Such signals can be paired two ways: with each other or, for higher quality cables, each of these signals can be paired with the Signal Ground.

Differential Devices are devices that use the above-described differential system for transmitting data and control signals. The most common Communications Standards dealing with interconnecting differential type devices are: RS-485, RS-422, RS-449, RS-423, RS-530, V.35, X.21, SCSI, Token Ring, Ethernet, etc.

By comparison, devices that do not use the differential system when transmitting data to another device are called Single-Ended. Examples of Single-Ended Communications Standards are: RS-232 Serial, CENTRONICS Parallel, and some SCSI.