



APPLICATION NOTE

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Product Family: N/A

Number: AN-MISC-031

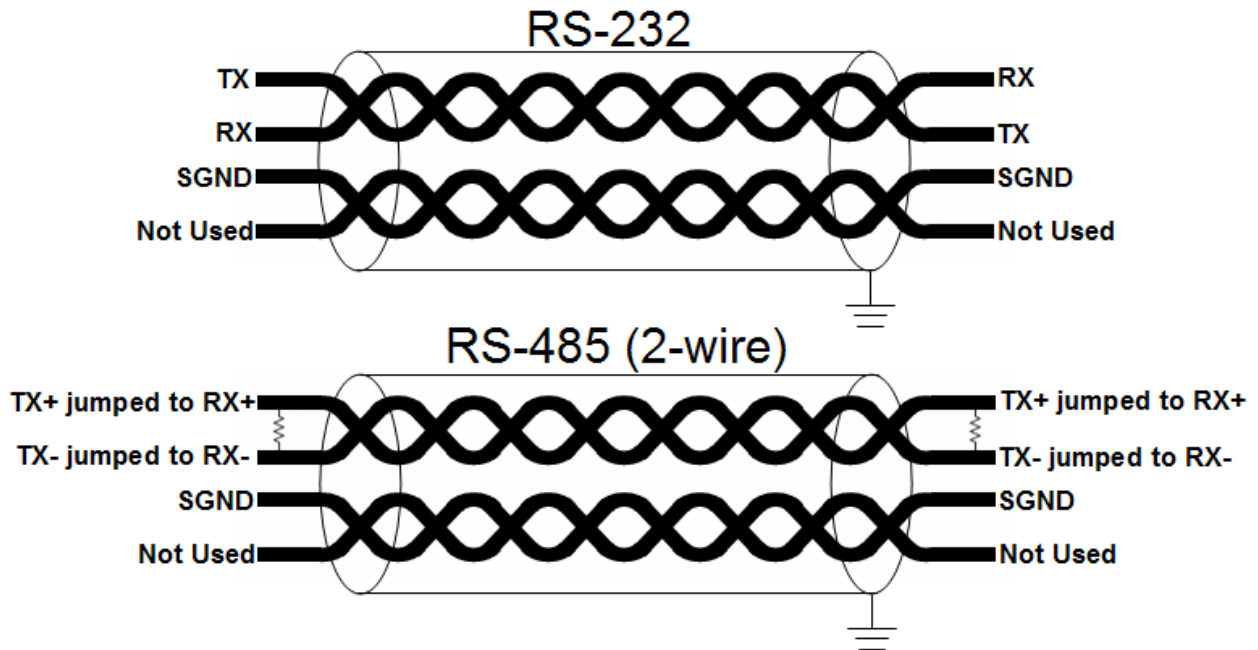
Subject: Best Communication Wiring Practices

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There are many important factors when trying to achieve good, reliable communications between 2 devices.

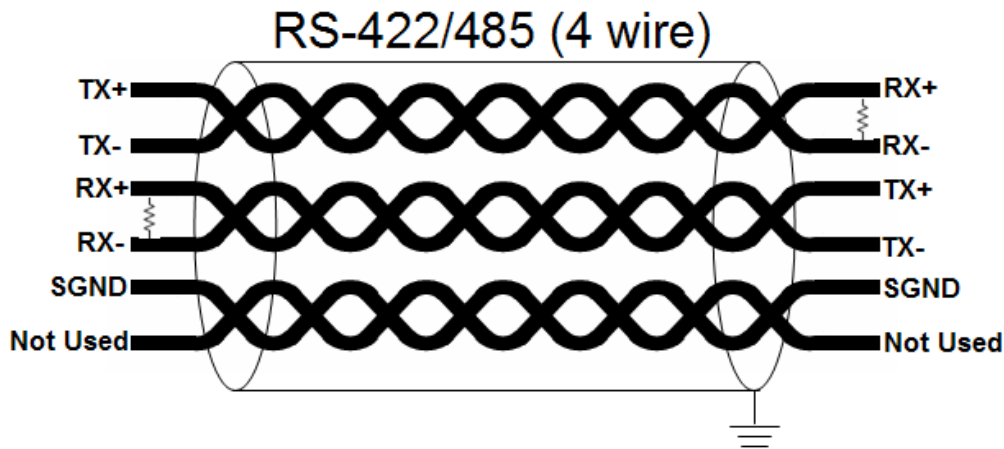
- Wiring the signals correctly
- Shielded cable with Logic Ground conductor
- Correct impedance cable
- Correct value Termination and Bias resistors and in the correct location
- Proper Strain Relief
- Physical Isolation from other signals/supplies
- Optical Isolation





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Wiring the signals correctly:

The above illustrations are examples of 3 different methods of wiring serial devices together. The above configuration is for wiring 2 DTE (Data Terminal Equipment) devices together. To wire a DTE device to a DCE (Data Communications Equipment), the TXs should go straight across and the RXs should go straight across. A DTE device is the end device that actually creates or receives the data. A DCE device is a device that only re-transmits the message. A PC or PLC is a DTE device. A Modem is a good example of a DCE device.

Shielded Cable with Logic Ground conductor:

It is important to use a shielded cable that has a separate conductor from the signal conductors that can be used as a Logic Ground. This should not be the drain wire. A Logic Ground signal is not always necessary for the data integrity. In RS-232, the logic ground is used as a reference for the RX and TX signals so it is absolutely necessary. In RS-485 and RS-422, the logic ground is not used as a reference signal. The logic ground serves the purpose of making sure that the grounds between the 2 devices are at the same potential. If the 2 devices have different grounds, this can create a potential difference between the 2 devices and could corrupt the signal or even cause damage to the circuitry. The drain wire should never be used because it is physically connected to the shield, so you can inadvertently bring noise into your device by using the drain wire as the logic ground connector.

The shield is used to defeat induced electrical noise into the data signal. The shield should be connected to earth ground at only one end of the cable.

It is also important to note that you need to use a twisted pair cable. Most cable manufacturers recommend a specific cable part number for the different standards (RS-232, RS-485, etc...) and so the cable 'should' have twisted pairs and a shield in this case. The twisted pair also helps to defeat induced noise so this is very important.



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Correct Impedance Cable:

It is important to match the impedance of the cable to the devices that are being connected together. If the cabling and devices are 'unbalanced' (different impedances) then reflections can occur and the signal integrity will be lost.

Typically RS-232 devices are at 100 Ohm impedance, RS-422 devices are at 100 Ohm impedance and RS-485 is at 120 Ohm impedance.

Proper Termination and Bias:

It is important that proper termination resistors are used and are in the correct location on a network. Termination resistors insure that the node impedance and the cable impedance match therefore preventing any reflections. Termination is only necessary for differential pairs so it is not necessary for RS-232.

The resistor value should match the cable impedance value. Typically, this is 100 Ohms on a RS-422 network and 120 Ohms on a RS-485 network.

The termination resistors should be located at the extreme ends of the network, not at the interim nodes. They should be on the receiver differential pairs at the device in the case of RS-422.

The purpose of 'biasing' is to keep the voltage level above +200mv or below -200mv when the bus is at an idle state. If the bus voltage level falls into the -200mv to +200mv range, it is considered to be in an 'error' state and erroneous data can occur at the beginning of a data packet. This can often be detected if a device has a RX LED that appears to be stuck on.

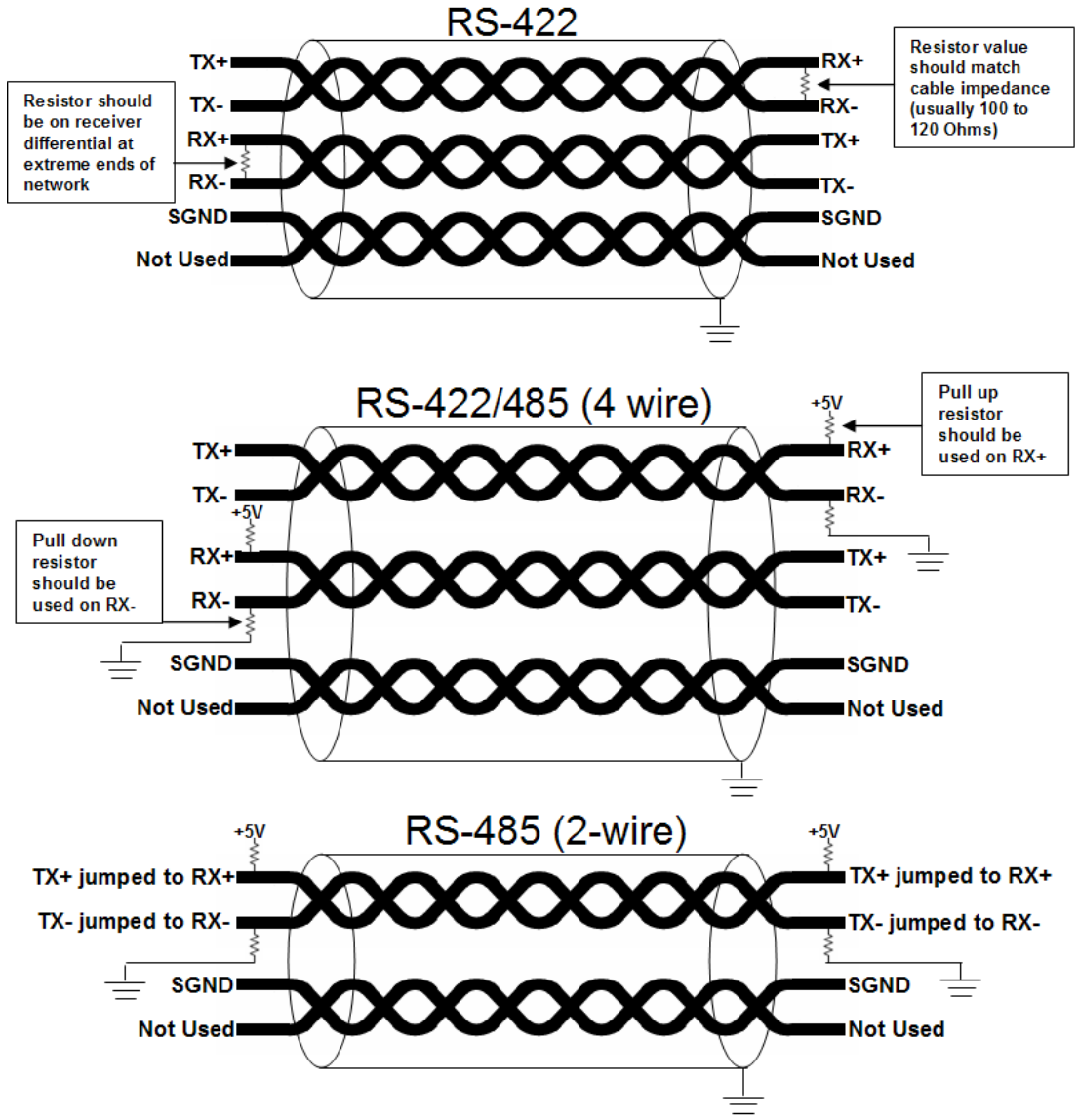
Biasing, by using a pull up resistor and pull down resistor prevents this from happening. Most devices used today do not require Bias resistors because they have a fail safe feature built in that drives the logic to a known signal when the bus is idle and in that -200mv to +200mv range.

Bias resistor calculations are a lot more complex than Termination Resistor calculations. In 2-wire mode (RS-485), a pull up resistor should be used on the + data line and a pull down resistor should be used on the - data line. In 4-wire mode, the pull up resistor should be used on RX+ and the pull down resistor on RX-. The value resistor used depends upon the network and the devices used. 4.7K Ohm is a very common value to use when Biasing each node. To find the correct value, the load impedances for the devices has to be considered and the value of the termination resistor also. You then use the Bias resistors to bring voltage of the bus in an idle state up to 200mv. Bias resistors are typically used at the extreme ends of the network but can be used on each node as well. Obviously, the load values would have to be calculated and distributed properly if used on each node. FA-ISOCAN bias resistor values are 1.2K Ohms and should only be used at the extreme ends of the network.



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Proper Strain Relief:

Proper Strain Relief should be used when building a cable. One of the most common causes of failure in communications is from cable damage. Very often this occurs from improper strain relief. Especially if the cable is connected to a device on a door and frequent closing and opening of the door causes the connector cable to flex. Liberal use of wire ties to secure the cable (especially at the point which the cable enters the connector) from flexing at a narrow point is suggested.

Be sure to use the correct connector hood and the strain relief clamp that comes with the connector hood when wiring a connector.



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Physical Isolation from other signals/supplies:

Another very common problem that occurs with communications is electrical noise induction. The use of properly shielded twisted pair cabling reduces the amount of noise injected into a device but it cannot totally eliminate a sufficient amount of radiated emissions. The only fail safe way to keep from compromising the data signal is by routing the communications signal separate from other signals and power supply cabling.

If comm. and power must be near each other, cross the cables at 90 degrees to minimize noise. Avoid running power and comm. parallel to each other.

Optical Isolation:

A communications cable not only allows devices to easily transfer data back and forth at distances across a facility or from facility to facility it also, unfortunately, allows a path for undesirable signals, currents and spikes to enter a device.

One way to reduce this effect and to create some protection for a device is to use optical isolation. An example of this is the FA-ISOCAN that we sell.

Sometimes it is better to run 4 wire RS-485 or RS-422 between 2 devices even when those devices are less than 50 feet from each other. Both 4-wire RS-485 and RS-422 are much more immune to electrical noise than RS-232 because of their differential signaling. If the environment is very noisy and there is no practical way to physically isolate the communications cabling, additionally adding FA-ISOCANs (or some other type of optically isolated communications device) at all of the devices should be considered.

Some recommended cable part numbers:

RS-232 = 8102

RS-485 (2 wire) = 9842

RS-485 (4 wire) = 9843

RS-422 = 8103

Technical

Assistance: If you have questions regarding this Application Note, please contact us at 770-844-4200 for further assistance.