

## CABLE SELECTION FOR RS-422 AND RS-485 SYSTEMS

### *Making sense of the specifications*

Selecting data cable for an RS-422 or RS-485 system isn't difficult, but often gets lost in the shuffle of larger system issues. Care should be taken, however, because intermittent problems caused by marginal cable can be very difficult to troubleshoot.

Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

**Characteristic Impedance (Ohms):** A value based on the inherent conductance, resistance, capacitance and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is cut to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. That is to say that the termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. If termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

**Shunt Capacitance (pF/ft):** The amount of equivalent capacitive load of the cable, typically listed in a per foot basis. One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefit from using low capacitance cable.

**Propagation velocity (% of c):** The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 78% gives a velocity of  $0.78 \times 300 \times 10^6 = 234 \times 10^6$  meters per second.

### *Plenum cable*

Plenum rated cable is fire resistant and less toxic when burning than non-plenum rated cable. Check building and fire codes for requirements. Plenum cable is generally more expensive due to the sheathing material used.

The RS-422 specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance. While the RS-485 specification does not specify cabling, these recommendations should be used for RS-485 systems as well.

It can be difficult to quantify whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the twisted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification. The extremely high volume of Category 5 cable used makes it widely available and very inexpensive, often less than half the price of specialty RS-422/485 cabling. The cable has a maximum capacitance of 17 pF/ft (14.5 pF typical) and characteristic impedance of 100 ohms.

Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations for RS-422 making it an excellent choice for RS-422 and RS-485 systems.