



**April 4, 2007**

### **RS485 (RS422 and RS232) Cable Information**

Per various phone conversations I am responding in an attempt to clarify the proper cable to use with RS485 (also, RS422 and RS232). In our opinion and experience, in most instances, involving communications up to 4000ft. and up to 100Kbps, the best choice of cable would be 24AWG twisted-pair wire with a characteristic impedance of 120-Ohms. The tolerance on the cable impedance is nominally +/-20% (144 to 96-Ohms). In general, higher impedance cable will yield better results. While the RS485 specification does NOT technically specify cable impedance, the RS485 driver ICs do have their limitations and, lower impedance cable can cause loading problems and/or reduce noise margins. In many instances Cat-5 cable with a characteristic impedance of 100-Ohms (24AWG, +/-20%) is used with good results. The transceiver ICs generally used in RS485/RS422 applications, are capable of delivering good voltages and currents into a load of 54-Ohms (under typical operating conditions). With termination of 120-Ohms on each end of the transmission line (120-Ohms also) the loading on an RS485 transmitter would be 60-ohms. Using Cat-5 cable and 120-Ohm termination on both ends would yield 54.5-Ohms and, for Cat-5 using 100-Ohms termination on both ends the loading would be 50-ohms.

It is my understanding that you have 22AWG cable installed at your job site with 68-Ohms characteristic impedance. The same analysis as above would yield a load of 34-Ohms if the cable is terminated on both ends with its characteristic impedance of 68-Ohms. The increased load causes the RS485 transmitter to deliver more current into the load, which has the effect of reducing the differential output voltage developed by the driver IC. Further, because your application uses a point-to-point configuration and is not a multi-drop network the loading is reduced and should help if you decide to use the existing 22AWG wire. While the probability is good that the this cable will work OK in most instances, the possibility does exist that some driver ICs could be marginal in this applications. Using higher characteristic impedance cable will insure that loading is reasonable, that noise margins are good, and interchangeability of converters will be possible.

Fortunately, "high-impedance cable" is readably available in heavier wire gauges. Using "high-impedance cable" in conjunction with the low resistance of heavy gage wire can significantly extend the nominal 4000ft. limit of RS485, especially in point-to-point applications. For example 16AWG vs. 24AWG will reduce the resistance by about a factor of six. In our opinion RS485 communications using 120-Ohm characteristic impedance 16AWG twisted wire, and newer CMOS transceiver ICs, should make point-to-point communications possible, for distances of 4.0 to 5.0 miles, at maximum data rates of about 9600bps to 19,200bps. Several Belden wires types are listed below.

BELDEN WIRE (See supplier/ordering information below):

9841 1-PAIR FOIL/BRAID 120-OHM 24AWG RS485  
9842 2-PAIR FOIL/BRAID  
9843 3-PAIR FOIL/BRAID

3105A 1-PAIR FOIL/BRAID 120-OHM 22AWG RS485  
3107A 2-PAIR FOIL/BRAID  
3108A 3-PAIR FOIL/BRAID  
3109A 4-PAIR FOIL/BRAID

3074F FOIL/BRAID 124-OHM 18AWG .460" DIAM RS485  
3073F FOIL/BRAID 100-OHM 18AWG .388" DIAM RS422

9860 1-PAIR FOIL/BRAID 120-OHM 16AWG .440" DIAM RS485

8102 2-PAIR w/SHIELD 100-OHM 24AWG RS232/RS422  
8103 3-PAIR w/SHIELD  
8104 4-PAIR w/SHIELD

Sorry for the delay in responding. I hope the above information will be helpful in determining how to proceed. Please give me a call if you have any additional questions or comments.

Thanks,

Ronald Smith

SUPPLIER/ORDERING INFORMATION:

WORLD CLASS WIRE & CABLE, INC.  
W234 N2092 RIDGEVIEW PARKWAY CT.  
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