Sensors and Wiring

PT1000 sensors

These sensors are made from Platinum wire and have a nominal resistance of 1000 ohms at 0°C. The resistance of the sensor changes by 3.85ohms for every degree change in temperature. When wiring these sensors any wiring resistance appears as an equivalent positive temperature offset. Not only does this affect the temperature reading but there is another source of error as well. All conductors exhibit an increase in resistance as the temperature increases and this increase in resistance is very similar for most common conductors. Thus if the wiring temperature changes its resistance also changes which introduces another source of error into temperature measurements made with resistance sensors.

Copper cables and platinum sensors

Copper has a resistivity of 0.0168ohm /square millimetre cross-sectional area/metre of length.
This means that a typical signal cable of 0.2mm^2 has a resistance of 0.0168 * 5 ohms/metre = 0.08 ohms/metre. In a 5metre cable run (ie 10 meters of actual copper conductor) this amounts to a resistance of 0.8ohm which is equivalent to a temperature error of 0.2°C for a PT1000 sensor and 2°C for a PT100 sensor. The position is a bit better if heavier duty cable is used. For cables of 1mm^2 the equivalent temperature errors are 0.04°C and 0.4°C respectively. For PT100 sensors even this error is quite significant. If longer cables are used the errors are worse. For a sensor located 50m from the measuring device and using cable having a cross-sectional area of 1mm^2 the temperature errors are 0.4°C for a PT1000 sensor and 4°C for PT100 sensors. Note that if you used cabling with a 0.2mm^2 cross-sectional area the PT100 sensor would exhibit an error of 20°C making it basically useless.

What does this mean in practice? The sensor MUST be located very close to the electronics and you should use as heavy a conductor as possible.

Wiring techniques

All wiring is subject to picking up stray signals which are coupled into the wiring via electrostatic and electromagnetic fields. Stray signals introduced into a signal lead look just like a real signal and are going to provide errors in readings. There are several ways to reduce stray pickup.

Shielded cables

These cables consists of a number of conductors enclosed in a woven wire shield. The shield is usually fitted with a drain wire which is used to provide electrical conductivity to the shield in an easily handled manner. The shield of these cables only provides protection against electrostatic pickup. It should be grounded to the system ground at ONE end only. The higher quality the cable the more metal there is a in the shield and the better its performance is. Don't skimp by using the cheapest cable!!! You are trying to make a system which works reliably. It is much better to use a good cable from the outset rather than having to use a cheap cable and replace it later with a good cable!

Twisted pair wiring

Electromagnetic fields couple into cables by a transformer action. If you lay one cable on top of one carrying AC power then what you have done is make a transformer where the field created by the power cable gets coupled into the signal cable. The larger the current in the cable the larger the magnetic field and the bigger the coupling. It is the current flowing through the cable which creates the field NOT the voltage. A mains cable carrying 10A at 24V is going to have a bigger field than one carrying 1A at 240V.
There are two ways to reduce this form of coupling. For a start it is essential that all signal cabling be physically well separated from mains wiring. The field around a conductor decreases by the square of the distance. Doubling the separation distance reduces pickup to one quarter.
The second technique consists of twisting the conductors in the signal cable. This results in the induced voltage changing polarity with every twist and thus it tends to cancel out. Most data cables are supplied as twisted pairs. The number of twists per metre isn't very significant. You can also make a

twisted pair cable from normal wire by just twisting the two wires together. One twist per every couple of centimetres is fine.

Recommendations

1. Always use high quality shielded pair twisted cable for data wiring with the shield grounded only at the amplifier end.
2. Keep data signals well removed from signals carrying AC wiring especially those carrying heavy currents.
3. Unless specifically permitted never let the data signal cables carry AC.
4. For Platinum type sensors use the heaviest duty cable that you can. This could even be building wire. You can twist this cable with a twist every metre of so to reduce electromagnetic coupling.

These recommendations sometimes need to be broken but only do so if specifically instructed by a manufacturer's data sheet.