When designing shielding, the following design points will reduce the effects of electromagnetic interference.

- Avoid “noisy” equipment when possible.
- Choose a metal cabinet that will shield the control electronics.
- Use shielded cables and twisted pair wires.
- Separate high current, and AC/DC wires from each other when possible.
- Use current oriented methods such as sourcing and sinking for logical I/O.
- Use high frequency filters to eliminate high frequency noise.
- Use power line filters to eliminate noise from the power supply.

13.5 SUMMARY

- A/D conversion will convert a continuous value to an integer value.
- D/A conversion is easier and faster and will convert a digital value to an analog value.
- Resolution limits the accuracy of A/D and D/A converters.
- Sampling too slowly will alias the real signal.
- Analog inputs are sensitive to noise.
- Analog shielding should be used to improve the quality of electrical signals.

13.6 PRACTICE PROBLEMS

1. Analog inputs require:
   a) A Digital to Analog conversion at the PLC input interface module
   b) Analog to Digital conversion at the PLC input interface module
   c) No conversion is required
   d) None of the above

(ans. b)

2. You need to read an analog voltage that has a range of -10V to 10V to a precision of +/-0.05V. What resolution of A/D converter is needed?

(ans.

$$R = \frac{10V - (-10V)}{0.1V} = 200$$

7 bits = 128
8 bits = 256

The minimum number of bits is 8.

3. We are given a 12 bit analog input with a range of -10V to 10V. If we put in 2.735V, what will

the integer value be after the A/D conversion? What is the error? What voltage can we calculate?

(ans.

$$N = 12 \quad R = 4096 \qquad V_{min} = -10V \qquad V_{max} = 10V \qquad V_{in} = 2.735V$$

$$V_I = INT\left[\left(\frac{V_{in} - V_{min}}{V_{max} - V_{min}}\right)R\right] = 2608$$

$$V_C = \left(\frac{V_I}{R}\right)(V_{max} - V_{min}) + V_{min} = 2.734V$$