Chapter 26: Floating Metal and Guard Electrodes

26.1 Provide three examples of floating metal objects not already given in this chapter.

26.2 For a single-line telephone, the red and green lines are used as the tip and ring. For a second-line telephone, the yellow and black wires are used as the tip and ring. If only one phone is needed in a home, what should be done with the remaining wires? Explain

26.3 The batteries for a small aircraft are placed in the rear end of light-weight plane to help counter balance the weight of the engine. Discuss the routing of the power lead(s) between the batteries, in the rear of the plane, and the electronics, located mostly in the front of the plane. Should the metal body of the plane be used as the power return?

26.4 Explain how the movement of a corrugated iron roof on a wooden shack near a high-voltage power line can produce radio and TV interference. What type of climate could increase the noise level?

26.5 A large floating conducting plane is placed parallel and above a signal trace already located above a large return plane. Therefore, the signal trace is located between the return plane and the floating plane. Will the inductance between the signal trace and the return plane decrease, increase, or remain the same after adding the floating plane? Explain.

26.6 Around some ferrite-based toroid transformers an external conducting shield is provided. Should this shield be left floating? Assume that electrostatic charge buildup is not an issue.

26.7 A portable signal generator with a single output lead is powered entirely by a battery. No part of the generator or battery is connected to any external ground or other conducting objects. The generator and battery are floating. If the signal input terminal of an oscilloscope (powered by the ac power line with its chassis grounded) is connected to the single output lead of the signal generator, will it measure the output of the generator? State all assumptions.

26.8 A sensor is used on the engine of a truck. The distance between the test equipment and sensor is 50'. Power-frequency noise is definitely a concern. Why should the sensor not be floated? What happens if it is single-ended grounded? Suggest a method of avoiding this noise during the measurement.

26.9 The output signal of bridge transducer powered by a dc voltage source is strongly interfered with by a 60 Hz signal. Only inexpensive twisted pair is available. Grounding at various locations does not cure the problem. How can the supply voltage (amplitude, frequency, or reference level) for the bridge be changed to reduce this noise problem? Assume the upper frequency response of the transducer is 100 Hz.

26.10 A low-level transducer, grounded, is connected to shielded twisted pair to a floating amplifier. The floating amplifier is to be powered by the ac line. How should it be connected to the ac line? The shield of the twisted pair is connected to the ground at the transducer. Why is the amplifier floating? At the amplifier,

a ground strap is connected between the return lead of the twisted pair and the shield. Why?

26.11 Are there any benefits in using a bridge when the amplifier connected to the bridge is single-ended?

26.12 Neither supply voltage leads to a motor are grounded. By connecting the chassis of the motor to the more negative lead, the noise emissions decrease. Explain.

26.13 A capacitor transducer with a source impedance of 400 MΩ at 20 Hz is connected to a coaxial cable. Assuming a typical input capacitance for 10 ft of the coax, determine the major negative consequence of this capacitance. What if the inductance of the line is included in the analysis? Would a piezoelectric transducer have a low or high source impedance?

26.14 A high-megaohm (1 GΩ or more) resistor inside a metallic case is to be measured. The resistor is supported by two, high quality insulators mounted to the case. What are a few possible candidates for these insulators? Some of the current through the high resistance, during the testing, passes through the insulators! What should be done? Hint: think of the metallic case as a guard electrode or add a guard electrode around one of the input leads. Carefully follow the path of the current to ensure that the resistance measured is due to the current through the high-impedance resistor.

26.15 Some test instruments are guarded. There are three output leads for guarded instruments: High, Low, and Guarded. When using a guarded instrument for measuring voltage across a resistor, where should the three leads be attached if the one side of the resistor is grounded? What if neither side of the resistor is grounded? What occurs if the High and Low leads are interchanged in both cases? [Keithley]

26.16 A floating microphone is connected to a differential amplifier through shielded twisted pair. The microphone is enclosed in a shield. Where should this shield be connected? The amplifier is not shielded, but it is enclosed in a chassis that is connected to ground for safety purposes.