# Transmitter EMI Reduction

One of the largest foes of accurately conditioning millivolt signals from strain gage based transducers is electromagnetic interference (EMI), or radiated noise. Each installation can require a different approach in order to avoid EMI problems. While most articles are correct in analyzing the sources of errors, the recommendations for hooking up the strain gage based transducer and transmitter don't seem to take into account the fact that the most desirable connections often can't be made because the points are not available. Connection points may be sealed inside an enclosure or not accessible due to construction requirements.

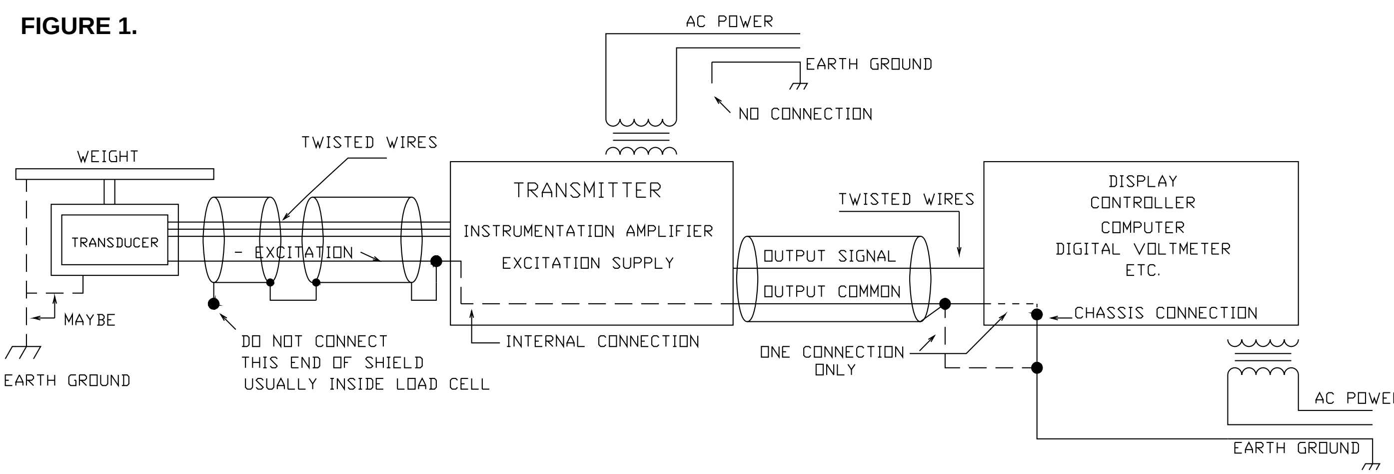
The purpose of this article is to provide the reader with a real world application that can be emulated to solve most noise related signal conditioning problems. Figure 1 illustrates this application example. Each component of the application is discussed individually. It is assumed that the transmitter contains a true instrumentation amplifier with common mode rejection capability and a bridge excitation power supply designed such that its reference signal is connected to the amplifier reference common.

## Transducer

Most transducers have their case galvanically isolated from the resistive strain resistors and the transducer leads are covered by a shield which ends inside and is not connected to any point. There is some capacity between the transducer resistive elements and the case. This capacity is generally between 50pF and 100pF. There will also be some capacity between the shield and the wires of approximately 20pF to 30pF per foot of shield. These two sources of capacity will couple AC signals into the signal paths and create errors which may or may not be significant. Most often these AC signals are 60 cps power line sources and are a result of the electric field. The magnetic field, which is generated by current flow, is the most difficult to shield against and the best thing to do is use twisted wires inside shields and only connect the shields at one end. Also, never run signal leads in the same conduit as AC power lines. Using separations of one foot can be effective against 60 cycle magnetic fields. If cables are run through conduit, use an insulated shield inside the conduit to cover the leads so there is no contact between the shield and the conduit.

Note in the Figure 1 that if the transducer leads require lengthening the shields must be connected and the unshielded length of the leads kept to a minimum.

**FIGURE 1.**



## Weight Table

The WEIGHT table shown in Figure 1 may also be connected to EARTH ground due to its physical structure. The case of the transducer will in general be electrically tied to this structure, either DC or through capacity if galvanically isolated, therefore any noise in the structure can couple through the capacity of the case to the transducer bridge resistors. The three EARTH grounds shown in Figure 1 may have DC and AC voltages with respect to each other and it may be necessary to try measurements with the weight table grounded and not grounded, if one has the choice.

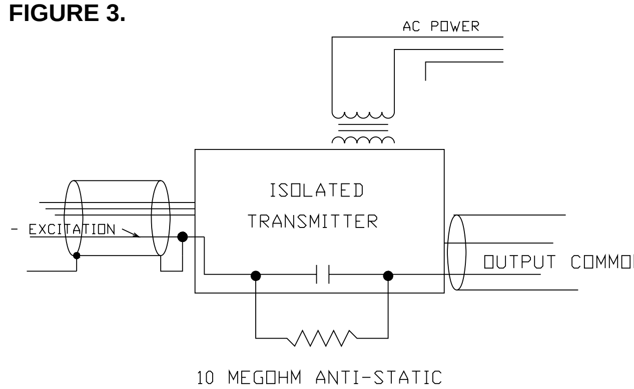
## Transmitter

Always place the transmitter as close to the transducer as is physically possible to minimize the length of leads between the transducer and the high gain amplifier. The capacities mentioned above are distributed in an unknown way and will not couple as common mode signals. Also note the power transformers in Figure 1 have capacity between their primary and secondary windings and current will flow through these capacities to get back to the EARTH power ground. The connections shown in Figure 1 allow current to flow in the high signal path rather than in the transducer signal path.

When a transmitter includes a bridge excitation supply, the excitation supply is always referenced to the amplifier's power supply. The amplifier's input current return path is then provided through the transducer resistors to the excitation supply and the amplifier common. Sometimes it is desirable to use an excitation source other than the transmitter excitation supply. This type of setup requires that a DC return path be provided for the finite input current of the amplifier. In order to accomplish this, one lead of the external excitation supply must be connected to the amplifier common to provide the input current return path. This is demonstrated in Figure 2. The DC common mode voltage at the amplifier input would be positive and 1/2 the excitation voltage. Always check the common mode range of the amplifier.

A word about isolated systems. In the case of an isolated transmitter, the internal COMMON connection shown will not be there. The connections still apply as a starting point. However, neither the transducer or the monitoring circuits should be left floating. Static electricity can build up until something breaks down. This may occur when someone gets close to the equipment or when the weakest insulator breaks down. This can be prevented by connecting a resistor of approximately 10 megohms from the circuit common to a grounding point which returns to the other part of the system, as in Figure 3. Although there will be some current flowing through the 10 megohm resistor, it will be on the same order as the currents flowing through 50pF to 100pF and generally will not cause problems.

**FIGURE 3.**




## Display

The box shown as a DISPLAY etc. in Figure 1 may or may not have its input signal common connected to its power line ground. This should be determined before making an additional connection as shown in Figure 1 so there is only one connection in the system to power EARTH ground.

When using transmitters, one must always consider the effects of EMI. Hopefully, the application examples presented above will provide a guideline for minimizing EMI related problems and keeping noise within acceptable limits. There will always be exceptions to these guidelines, but they provide an excellent starting point for a system evaluation.

**FIGURE 2.**