# Grounding and Shielding

- Measuring analog signals within a data acquisition (DAQ) system is not always as simple as wiring the signal source leads to the measurement equipment.
- Data integrity is dependent on clean electrical signals being sent to and received from the electrical devices being controlled and monitored.
- Electrical noise can obscure these signals and make them unrecognizable, impairing an otherwise fine DAQ system.

- Every electronic circuit used for measurement has encountered interferences of some sort. Electronics often makes use of power from the local utility which is grounded for reasons of safety.
- Electronic HW often interface with this power and share the same earth connection. The result can be interference.
- Controlling noise in measurement systems is vital because it can become a serious problem even in the best instruments and data acquisition hardware.
- Most laboratories and industrial environments contain abundant electrical-noise sources, including AC power lines, heavy machinery, radio and TV stations, and a variety of electronic equipment. Radio stations generate high-frequency noise, while computers and other electronic equipment generate noise in all frequency ranges.

- Building a completely noise free environment just for running tests and measurements is seldom a practical solution.
- Fortunately, simple devices and techniques such as using proper grounding methods, shielded and twisted wires, signal averaging methods, filters, and differential input voltage amplifiers can control the noise in most measurements.
- Some techniques prevent noise from entering the system, while others remove extraneous noise from the signal.

Grounding and shielding are mandatory to guarantee the integrity of a measurement. In practice, Noise effects can be reduced with adequate project, installation, cable distribution, grounding and shielding techniques.

Inadequate grounding can be the source of undesired and dangerous potentials that may impair the effective operation of the equipment or the system itself.

- **Electrostatic Noise:** A voltage will be induced in a conductor when exposed to a time varying electrical field. This is also commonly referred to as *capacitively coupled noise*. The following sources of electrostatic noise are common when dealing with data acquisition systems:
- Variable frequency drive (VFD) motor cables
- Switch mode power supply conductors
- Fluorescent lights
- Squealing bearings
- **Electromagnetic Noise:** A current will be induced in a conductor when exposed to a time varying magnetic field. This is commonly referred to as *inductively coupled noise*. The following are common sources of electromagnetic noise:
- VFD motor cables
- AC power cables
- Switch mode power supply conductors
- Solenoid power contactors
- Ground loops

# Grounding

- Electrical grounding or “Grounding” originally began as a safety measure used to help prevent people from accidentally coming in contact with electrical hazards
- **GROUNDING is a technique that provides a low resistance path between electrical or electronic equipment and the earth or common reference low impedance plane to bypass fault current or noise.**
- **Grounding, or connecting some part of an electrical circuit to ground** ensures safety for personnel and it usually improves circuit operation.
- Computers, televisions, microwave ovens, fluorescent lights and many other electrical devices, generate lots of “electrical noise” that can damage equipment and cause it to work less efficiently.
- Proper grounding can not only remove this unwanted “noise”, but can even make surge protection devices work better

## Generally Grounding serves the following principal purposes

- It provides an electrical supply system with an electrical reference to the groundmass. By connecting a particular point of the supply source to the ground, it is ensured that any other point of the system stays at a certain potential with reference to the ground.
- A metallic surface  of the enclosure of an electrical system is grounded to ensure that it stays at ground potential always and thus remains safe to persons who may come in to contact with it.
- It provides a low impedance path for accumulated static charges and surges caused by atmospheric or electrical phenomenon to the ground thus ensuring that no damage is caused to sensitive equipment and personnel.

# Shielding

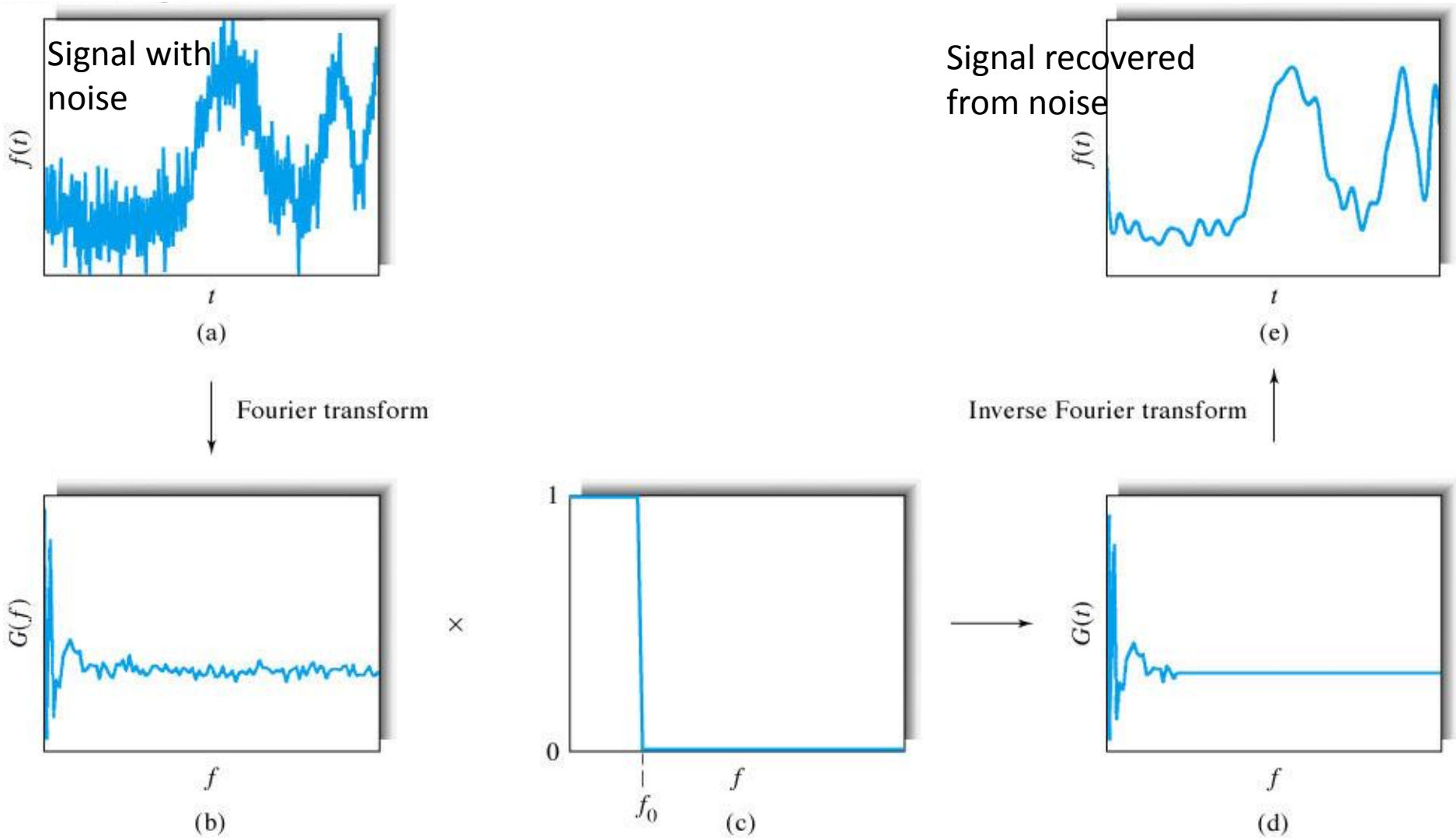
- Proper use of shielded cables in a data acquisition system will help minimize common mode electrostatic noise.
- Theoretically, when a shield surrounds a signal wire(s), the signal wire will capacitively couple to the shield but cannot capacitively couple to any conductors outside the shield.
- Now, this works both ways and can be used to keep electrostatic noise out of the conductors within a shield cable but can also be used to keep electrostatic noise contained within the shield.

- A **shielded cable** is an electrical cable of one or more insulated conductors enclosed by a common conductive layer.
- The shield may be composed of braided strands of copper(or other metal, such as aluminium), a non-braided spiral winding of copper tape, or a layer of conducting polymer.
- Usually this shield is covered with a jacket. The shield acts as a Faraday cage to reduce electrical noise from affecting the signals, and to reduce electromagnetic radiation that may interfere with other devices.
- The shield minimizes capacitively coupled noise from other electrical sources. The shield must be applied across cable splices.
- In shielded signal cables the shield may act as the return path for the signal, or may act as screening only.
- High voltage power cables with solid insulation are shielded to protect the cable insulation, people and equipment

# Digital Filtering

**3. Digital filtering:** Digital filtering can be accomplished by number of different well-characterized numerical procedure such as (a) Fourier transformation and (b) Least squares polynomial smoothing.

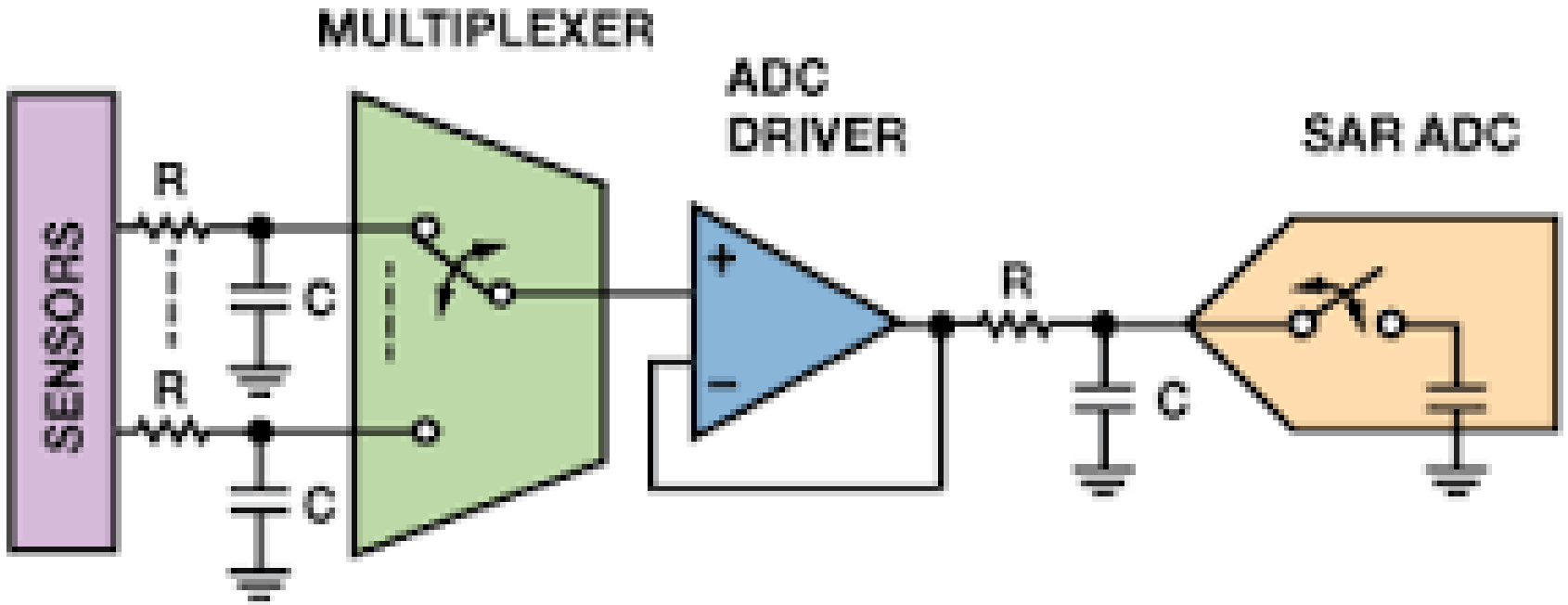
**(a) Fourier transformation:** In this transformation, a signal which is acquired in the time domain, is converted to a frequency domain signal in which the independent variable is frequency rather than time. This transformation is accomplished mathematically on a computer by a very fast and efficient algorithm. The frequency domain signal is then multiplied by the frequency response of a digital low pass filter which remove frequency components. The inverse Fourier transform then recovers the filtered time domain spectrum.



# Analog Multiplexer/ deMultiplexer

- A multiplexer is a device that can select from several different input signals and transmit either one or more output signals.
- A demultiplexer is a device that can take a single signal carrying multiple payloads and divide it into several streams.
- Some devices can do both multiplexing and demultiplexing functions and are therefore called multiplexers/demultiplexers

- **Types of Analog Multiplexers / Demultiplexers**
- There are many different kinds of analog multiplexers / demultiplexers.
- They are categorized by Signal Type, Configuration, ON Resistance, Supply Voltage, Packaging Type and No. of Channels.
- The most common values for No. of Channels are 2, 4 and 8 channels.


MULTIPLEXER
ADC
DRIVER
SAR ADC
SENSORS
R
R
C
C
+
−
R
C

## Applications for Analog Multiplexers / Demultiplexers:

Analog multiplexers / demultiplexers are used in several applications such as:

- Data acquisition systems
- Automatic test equipment (ATE) systems
- Audio signal routing
- Battery powered systems
- Medical instrumentation
- Single supply systems

# Analog Multiplexor