Practical considerations in using IEPE accelerometers with modern data acquisition systems

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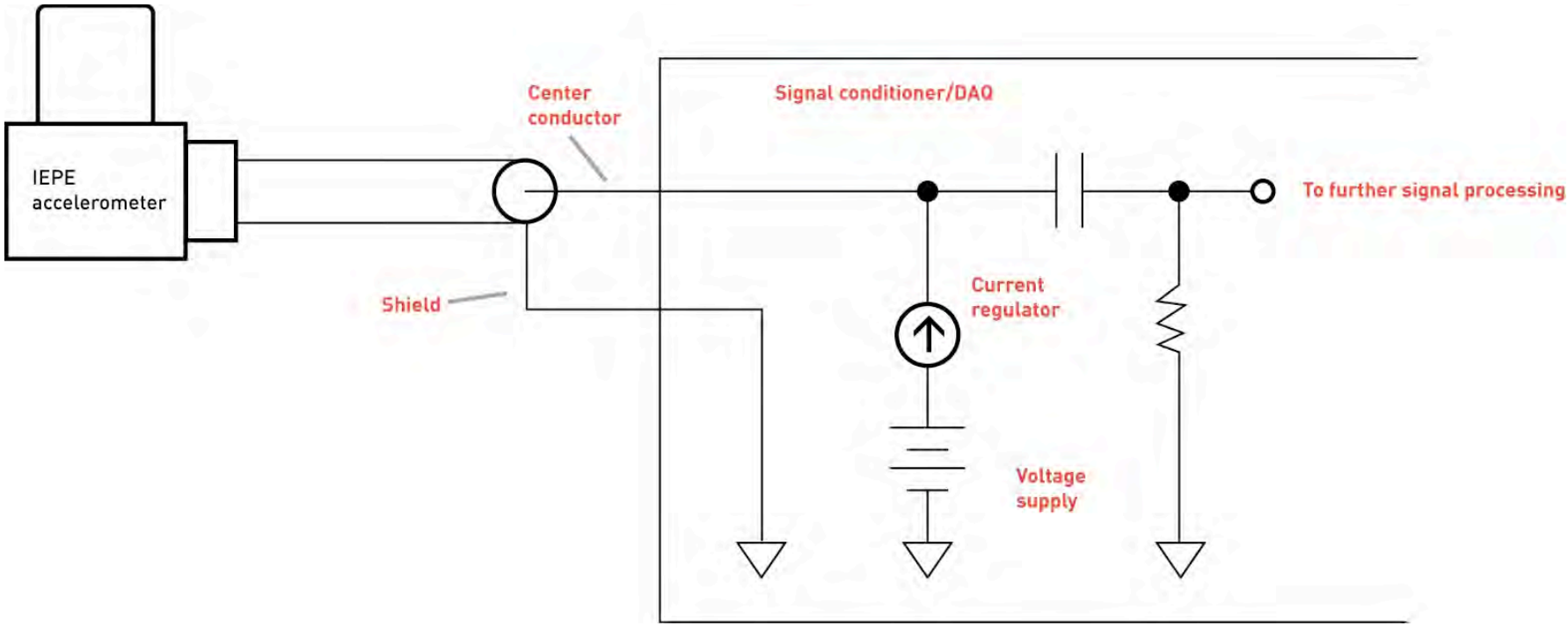
Introduction

- Sensor manufacturers have offered high quality signal conditioning amplifiers for years
- Accelerometer makers in particular offer amplifiers for piezoelectric charge (PE) and piezoelectric voltage (IEPE) accelerometers
- Highly flexible, allowing almost any combination of input and output scale factors
- Output intended for use with a downstream data acquisition system

Introduction

- Historically, accelerometer manufacturers have not offered a data acquisition product, being satisfied with a signal conditioning offering
- With the rapid rise in popularity of IEPE accelerometers, several DAQ system vendors now offer IEPE accelerometer signal conditioning integrated into their systems
- A convenient, cost effective approach, but there are factors to consider when using these IEPE/DAQ systems, to ensure the quality of measurement is at the level required
- We will examine these factors one at a time

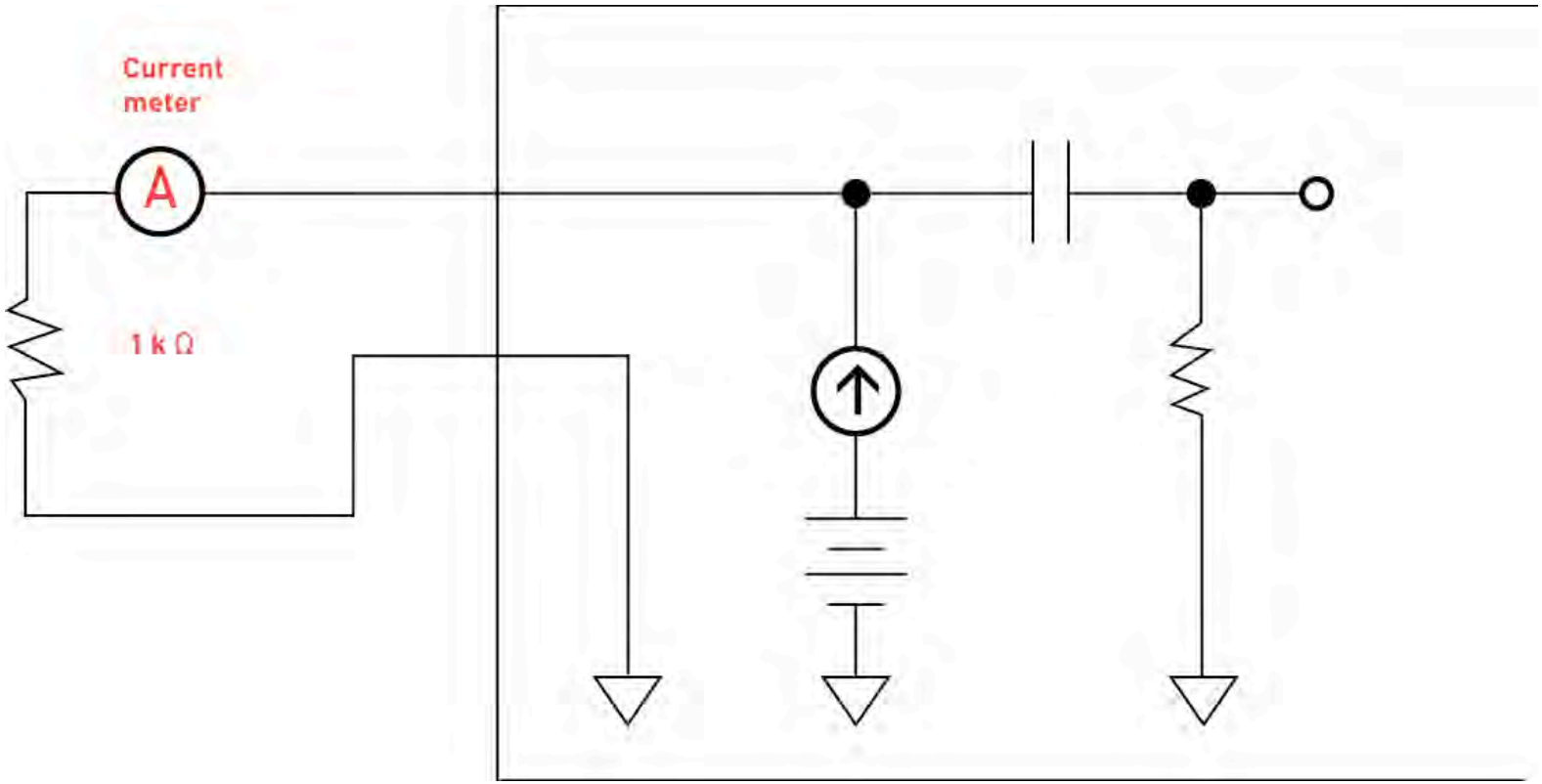
IEPE signal conditioning



Power requirements - current

- Always refer to accelerometer's datasheet for power requirements, as there is no "standard" IEPE power
- Current requirements are often specified as a range, with minimum often being 2 mA, maximum sometimes as high as 20 mA
- The user must ensure the IEPE signal conditioner/DAQ can supply the minimum current required by the accelerometer
- Current supply capability of DAQ should be specified in datasheet – if not, it can be measured

Power requirements - current



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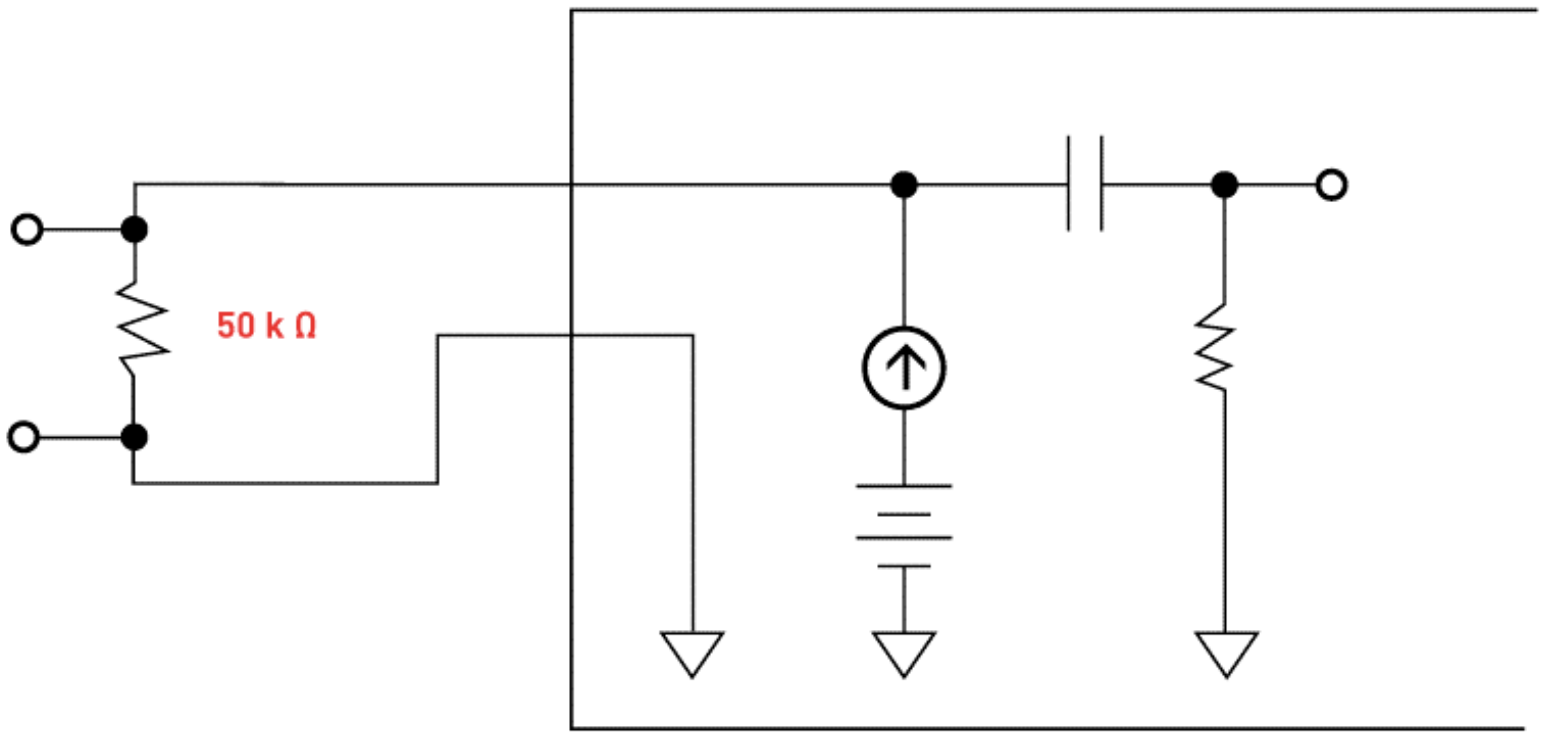
Power requirements - current

- Note that more current than the specified minimum may be required, if application involves long cable lengths, and/or high amplitude, high frequency vibrations

Power requirements – compliance voltage

- Accelerometer also requires a voltage in order to transmit a signal in a distortion free manner
- Known as the compliance voltage, it is the maximum voltage available from the constant current source
- As with the current, it is specified as a range, with minimum often being 18 Vdc, maximum as high as 30 Vdc
- User must ensure their IEPE signal conditioner/DAQ can supply minimum compliance voltage required by the accelerometer
- If not specified by the DAQ supplier, approximate value can be measured

Power requirements – compliance voltage



Power requirements – compliance voltage

- In some certain circumstances, it may be permissible to operate an IEPE accelerometer below the required minimum current and voltage
- Under no circumstances should an accelerometer be operated above specified maximums – doing so risks permanent damage to the sensor

Noise considerations

- Many IEPE accelerometers have excellent noise performance, the user must ensure the IEPE signal conditioner/DAQ system does not degrade this performance
- Some lower cost DAQ systems, particularly battery and USB powered units, can exhibit excess noise
- The culprit is typically a poorly or cheaply designed switching DC-to-DC converter in the power supply
- Not much the user can do about these, other than to be aware and avoid

Frequency response – high frequency

- Frequency response of IEPE accelerometers are usually well specified, user must consider what affect the IEPE signal conditioner/DAQ has on this response
- High frequency response is dependent on maximum acceleration, length (or capacitance) of cable and current available from DAQ system
- This dependency can be expressed as:

$$f_{max} = I / 2paSLC$$

Frequency response – high frequency

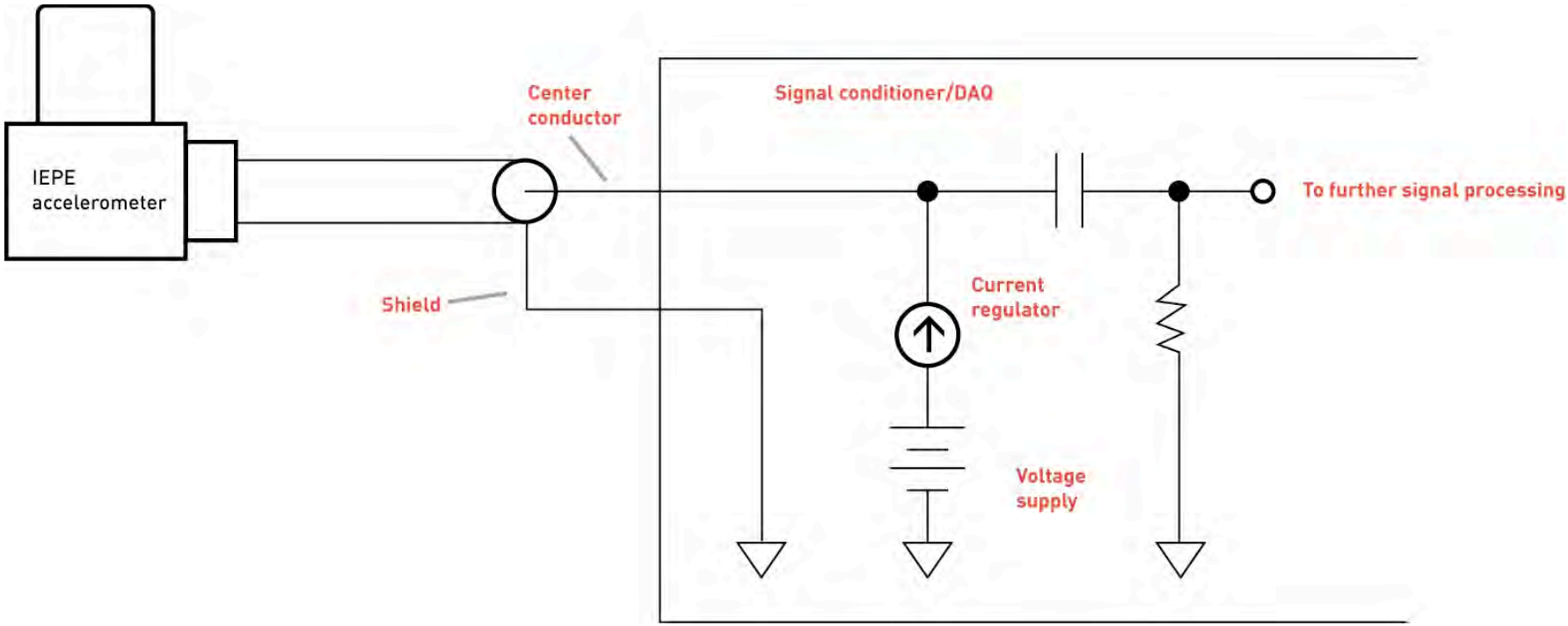
$$f_{max} = I / 2\pi aSLC$$

- Long cables (increased capacitance) will reduce system bandwidth
- If required to measure high amplitude accelerations and/or accelerations at high frequency, user must ensure the IEPE signal conditioning/DAQ system can supply sufficient current to achieve the system bandwidth required for the measurement

Frequency response – low frequency

- IEPE accelerometers output a DC bias voltage when properly powered, with the AC dynamic signal riding on this bias
- This DC bias must be stripped off in order for the dynamic signal to be further processed
- A simple RC network is typically used to do that, setting a low frequency cut off in the signal conditioner/DAQ system
- User must ensure this low frequency cut off is low enough for the measurement they are trying to make

Frequency response – low frequency



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Conclusion

- Ensure signal conditioner/DAQ supplies required current for the accelerometer
- Ensure signal conditioner/DAQ supplies required compliance voltage for the accelerometer
- Consider noise performance of signal conditioner/DAQ
- Consider high frequency response of the system, in particular ensuring signal conditioner/DAQ supplies adequate current in addition to minimum required
- Consider low frequency response of the system

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Questions?