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# INFLUENCE OF IEPE CABLE LENGTH ON SYSTEM FREQUENCY RESPONSE

**Introduction**

Integrated Electronics Piezo-Electric (IEPE) sensor systems are widely used for vibration and dynamic measurements due to their robustness and simplified signal conditioning. While IEPE technology minimizes many traditional cable-related limitations seen in charge-output sensors, cable length still influences the overall system frequency response. The primary mechanism is cable capacitance, which interacts with the sensor output impedance and the signal conditioning electronics. Understanding these effects is critical in high-accuracy and high-frequency measurement applications.

The primary electrical consequence of increasing cable length is added capacitance. Typical coaxial cables exhibit 50–150 pF per meter. As cable length is added, total capacitance increases proportionally, this combined with the sensor's output impedance, forms a low-pass filter. Worth mentioning is also that one can alter the sensor's output impedance via coupler current. Although IEPE outputs are low impedance, excessive capacitance reduces high-frequency bandwidth and slightly attenuate fast transient signals. For most industrial vibration measurements below 10 kHz, cable lengths up to 100 meters generally introduce negligible distortion. However, high-frequency applications (e.g., >20–50 kHz or shock measurements) may experience measurable signal roll-off and slower rise times.

**Kistler Group**
Eulachstrasse 22, 8408 Winterthur
Switzerland
Tel.: +41 52 224 1111
**www.kistler.com**

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## Practical example

The following graph shows the cable length (y axis) as a function of cut-off frequency (x axis). The curves show different currents with a typical cable capacitance of 100 pF/m (e.g. KISTLER connection cable family 1631Cx or 1761Bx). These results were measured at a signal amplitude of –0.1 dB (approx. –1%) and –3 dB (approx. –30%).

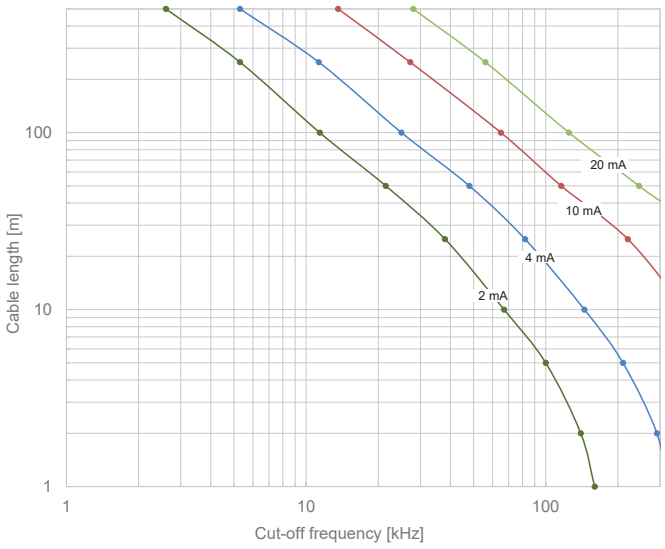



Fig. 1: Max. cable length vs frequency, @5 V output signal and –3 dB

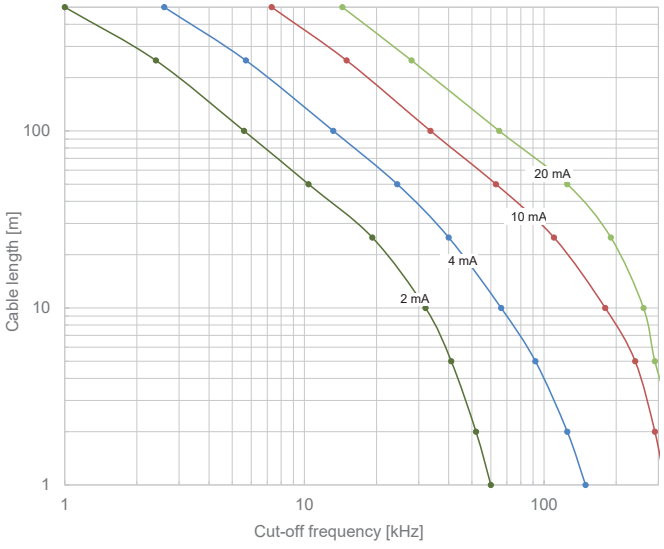



Fig. 2: Max. cable length vs frequency, @5 V output signal and –0.1 dB

## Conclusion

As a general engineering guideline, at –3 dB.

- Low-frequency measurements (below 3 kHz) can tolerate cable lengths of several hundred meters (@ 2 mA current).
- Mid-range frequencies (10–70 kHz), lengths are typically limited to 10–100 meters (@ 2 mA current).
- High-frequency applications above 100 kHz often require cables shorter than 10 meters and higher coupler current (≥2 mA).

Ultimately, the maximum length possible for a required frequency, depends on total system capacitance and the acceptable signal amplitude threshold.

Mastering the relationship between frequency and current to get the maximum allowable length is not just a technical detail – it is the foundation of high-performance IEPE systems. When engineered correctly, your signal stays strong, your measurements stay accurate, and your system performs exactly as designed.

Be aware that, although not covered in this document, if a situation arises where a user does not have an option to reduce the cable length or to increase the coupler current, one can still reduce the signal amplitude to increase the bandwith.

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Switzerland
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