Piezoelectric Accelerometer: Charge and Voltage Output

Charge from a piezoelectric accelerometer, charge amplifier output, voltage-mode output loss from cable capacitance, and the amplifier's low-frequency cut-off.

Method: Piezoelectric transducer and charge amplifier

Input parameters

Unit system: SI

Parameter	Value	Unit
Charge sensitivity (pC per g)	10.000	
Acceleration	5.0000	g
Charge amplifier feedback capacitance	1,000.0	pF
Feedback resistance	1,000.0	MΩ
Accelerometer capacitance	1,200.0	pF
Cable capacitance	1,000.0	pF

Calculated results

Parameter	Value	Unit
Charge	50.000	pC
Charge amplifier output	50.000	mV
Voltage-mode output with cable	22.727	mV
Voltage loss from the cable	45.455	%
Low-frequency cut-off	0.15915	Hz

Notes for this case

• A piezoelectric accelerometer produces charge q = S_q·a. A charge amplifier converts it to V = q/C_f regardless of cable length, because the cable capacitance sits at virtual ground. A plain voltage amplifier sees q/(C_s + C_c), so long cables reduce the signal. The feedback resistor sets the low-frequency limit f_L = 1/(2πR_fC_f). IEPE sensors have the amplifier built in and avoid this issue.

Formula and method

$$q = S_q a, \quad V_o = \frac{q}{C_f}, \quad V_v = \frac{q}{C_s + C_c}, \quad f_L = \frac{1}{2\pi R_f C_f}$$

Variables

S_q	Charge sensitivity (pC per g)	-
a	Acceleration	m/s²
C_f	Charge amplifier feedback capacitance	F
R_f	Feedback resistance	Ω
C_s	Accelerometer capacitance	F
C_c	Cable capacitance	F
q	Charge	C
V_o	Charge amplifier output	V
V_v	Voltage-mode output with cable	V
$C_c/(C_s + C_c)$	Voltage loss from the cable	-
f_L	Low-frequency cut-off	1/s

Method and standards

Charge amplifier.

Assumptions and limits

- Ideal charge amplifier; linear sensor.

References

Piezoelectric transducer and charge amplifier

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/vibration-noise/accelerometer-charge-amplifier

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.