

UNIVERSITETET I OSLO

Det matematisk-naturvitenskapelige fakultet

Eksamen i:	FYS3230
Eksamensdag:	13. desember 2011
Tid for eksamen:	9:00 – 12:00
Oppgavesettet er på 2 side(r)	
Vedlegg (2 sider):	Datablad for Brüel & Kjær 4374 Akselerometer
Tillatte hjelpemidler:	Kalkulator, matematisk formelsamling (Rottmann)

Kontroller at oppgavesettet er komplett før du begynner å besvare spørsmålene.

Oppgitte størrelser:

$$1 \text{ g} \cong 10 \text{ m/s}^2$$

$$1 \text{ pF} = 10^{-12} \text{ C/V}$$

$$1 \text{ pC} = 10^{-12} \text{ C}$$

1. Sensorkarakteristikk (Piezoelektrisk akselerometer)

Se på databladet for vedlagte akselerometer, 4374, og anta at det skal brukes til å måle responsen på harmoniske svingninger. Hva er:

- Følsomheten
- Full scale input (FSI)
- Full scale output (FSO)
- Hvilken elektrisk størrelse i databladet er det som bestemmer utgangsimpedansen.
- Kan dette akselerometeret brukes som inklinometer? (Begrunn svaret.)

2. Temperaturmåling

Nevn 3 fysiske prinsipper som er hyppig brukt i temperaturmålinger.

3. Støy

Et sensorelement er koblet til utlesningselektronikken med to parallelle ledninger som er 2 meter lange. Det viser seg at det er veldig mye støy på målingene. Støyen ligger i et frekvensområde rundt 100 MHz.

- Hva kan denne støyen skyldes?
- Støyen kan reduseres ganske enkelt – hvordan?

4. "Sample and hold" krets

I lab oppgave 2 ble det benyttet en "sample and hold" krets

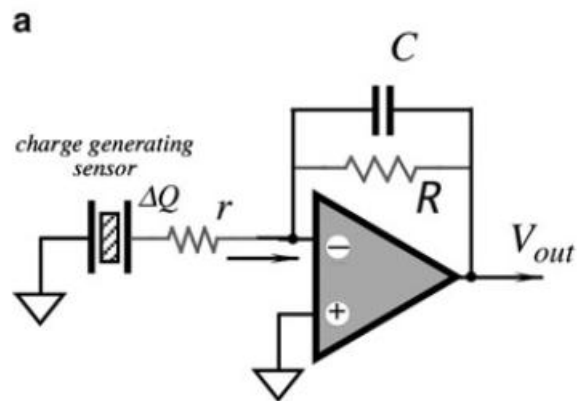
- Hva oppnår man med en "sample and hold" krets?
- Skisser en "sample and hold" krets og beskriv hensikten med de forskjellige komponentene.

5. Trykksensorer

Nevn to typer trykksensorer som egner seg for måling av trykk i området 1-10 bar.

6. Ladningsforsterkning

Kretsen under kan brukes til å konvertere ladning til spenning. Ladningen kan komme fra en ladningsgenererende sensor, slik som akselerometeret fra oppgave 1.



Anta at:

- kapasitansen i tilbak koblingen er: $C=1 \cdot 10^{-9}$ F
 - motstanden i tilførselen, r , er så liten at den kan neglisjeres
 - motstanden i tilbak koblingen, R er så stor at den kan neglisjeres
- a) Hvor stor blir utgangsspenningen V_{out} hvis sensoren genererer en ladning på 100 pC?
 - b) Hva blir amplituden på utgangssignalet V_{out} hvis man benytter akselerometeret 4374 som sensor og akselerometeret utsettes for en akselerasjon som har 1 g amplitude og en frekvens på 160 Hz?

PRODUCT DATA

Piezoelectric Accelerometer

Subminiature Charge Accelerometers — Types 4374, 4374-S and 4374-L

Uses

- High-level, high-frequency measurements
- Measurements in confined spaces
- Measurements on delicate structures
- Vibration testing and analysis

Description

Type 4374 is a piezoelectric, Planar Shear accelerometer. The integrated side cable terminates with a 10–32 UNF connector. Type 4374 is mounted on the object adhesively.

Characteristics

This piezoelectric accelerometer may be treated as a charge source. Its sensitivity is expressed in terms of charge per unit acceleration (pC/g).

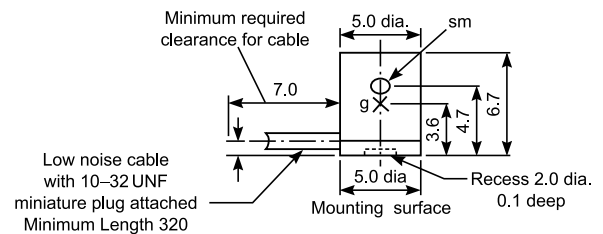
In the Planar Shear design, the piezoelectric element undergoes shear deformation as in the DeltaShear[®] design. Two rectangular slices of piezoelectric material are arranged on each side of a rectangular centre post. The two masses are held in position using a high tensile strength clamping ring. The ring prestresses the piezoelectric elements to give a high degree of linearity. The charge is collected between the housing and the clamping ring. The piezoelectric element used in Type 4374 and Type 4734-S is PZ27. With Type 4734-L, PZ23 is used. The housing material is INCONEL[®].



Calibration

The sensitivity given in the calibration chart has been measured at 159.2 Hz and an acceleration of 10 g. For 99.9% confidence level, the accuracy of the factory calibration is $\pm 2\%$.

Outline with Dimensions



Dimensions in millimetres

791003/5e

Specifications – Subminiature Charge Accelerometers Types 4374/S/L

	Unit	4374/4374-S	4374-L*
Dynamic Characteristics:			
Charge Sensitivity (@ 159.2 Hz)	pC/ms ⁻² (pC/g)	0.15 ±20% (1.5)	0.11 ±15% (1.1)
Frequency Response		See typical amplitude response	
Mounted Resonance Frequency	kHz	85	
Amplitude Response ±10%†	Hz	1 to 26000	
Transverse Sensitivity	%	<5	
Transverse Resonance Frequency	kHz	21	
Electrical Characteristics:			
Min. Leakage Resistance @ 20°C	GΩ	≥20	
Capacitance	pF	600	
Grounding		Signal ground connected to case	
Environmental Characteristics:			
Temperature Range	°C (°F)	-74 to +250 (-101 to +482)	
Humidity		Sealed	
Max. Operational Sinusoidal Vibration (peak)	g pk	5000	
Max. Operational Shock (±peak)	g pk	25000	
Base Strain Sensitivity	Equiv. g/μ strain	0.0005	
Thermal Transient Sensitivity	Equiv. g/°C (g/°F)	1 (0.56)	
Magnetic Sensitivity (50 Hz – 0.03 tesla)	g/T	3	
Physical Characteristics:			
Dimensions		See outline drawing	
Weight	gram (oz.)	0.65 (0.02)	
Case Material		INCONEL	
Connector		Integral cable 10–32 UNF	
Mounting		Adhesive	

* Type 4374-L is designed to be used with Hand-Arm Transducer Set Type 4392

† Low-end response of the transducer is a function of its associated electronics

Ordering Information

Type 4374 Subminiature Charge Accelerometer
Includes the following:

- Carrying Box
- Calibration Chart
- AO-0038-D-012: Low-noise Cable fitted with 10–32 UNF Connectors, 1.2 m (4 ft)
- 10–32 UNF Microdot Extension Connector

Type 4374-S Subminiature Charge Accelerometer with Accessory Box

Includes the following:

- Carrying Box
- Calibration Chart
- AO-0038-D-012: Low-noise Cable fitted with 10–32 UNF connectors, 1.2 m (4 ft)
- UA-1079: Accessory Box including:
 - 10–32 UNF Microdot Extension Connector
 - Input Adaptor, TNC to 10–32 UNF Microdot
 - Case of Beeswax
 - Washer

Type 4374-L Subminiature Charge Accelerometer for Hand-Arm Vibration

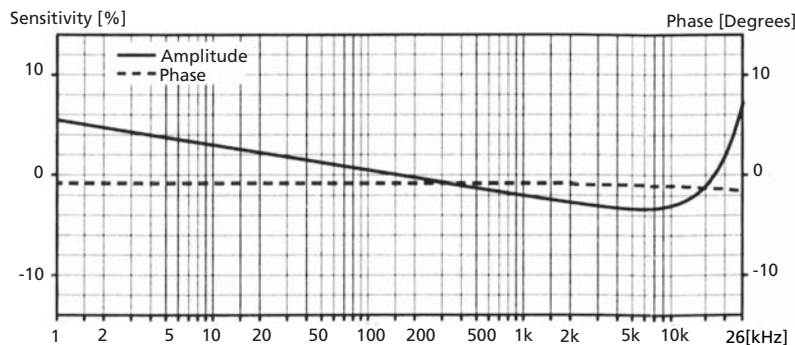
Includes the following:

- Carrying Box
- Calibration Chart
- 10–32 UNF Threaded Steel Stud. Length 12.7 mm (0.5 in)
- 10–32 UNF Microdot Extension Connector

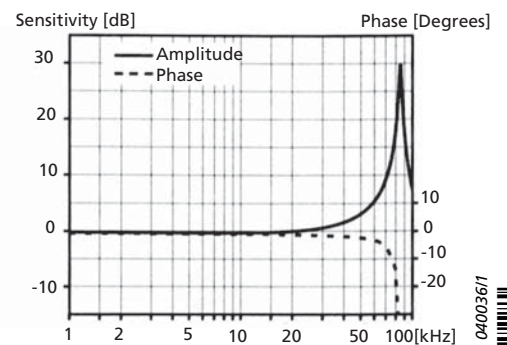
Optional Accessories:

- AO-0038-D-012 260°C TEFLON® Low-noise Cable, 10–32 UNF, length 1.2 m (4 ft)
- AO-0122-D-030 250°C, Reinforced Super Low-noise Cable, 10–32 UNF, 3 m (10 ft)
- AO-1382-D-012 Teflon Low-noise Cable, Double Screened 10–32 UNF, 1.2 m (4 ft)
- JJ-0032 Extension Connector 10–32 UNF
- JJ-0207 2-pin TNC to 10–32 UNF Plug Adaptor
- JP-0162 10–32 UNF to TNC Connector Adaptor
- QS-0007 Tube of Cyanoacrylate Adhesive
- YJ-0216 Beeswax for Mounting

Typical Frequency Response



Typical High Frequency Response



TRADEMARKS

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HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Local representatives and service organisations worldwide

Brüel & Kjær

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