THE USE OF BU SERIES ACCELEROMETERS

These notes are intended as a guide to the use of BU series accelerometers and not as a substitute for BU model specifications.

OVERVIEW

The BU is a small, single-axis low mass piezo-ceramic accelerometer with audio bandwidth. The most common usage is as a contact microphone picking up vocal vibrations through bone conduction. The inbuilt FET amplifier and high mechanical shock resistance also make this device, if mechanically protected, suitable for industrial applications.

Below 5 kHz, the transverse sensitivity is at least 20 dB below the main axis sensitivity.

The outer casing is type 305 stainless steel, epoxy sealed and with solder pad terminations for attaching lead wires. It may be safely potted with epoxy if required (provided that the temperatures resulting from exothermic reactions are maintained below 100°C).

BU is available in standard sensitivity or with mass added to the piezo element for increased sensitivity.

MECHANICAL

For bone-conducted voice pick-up:

Resilient mounting is required to provide predictable contact force yet still allow vibration. Various techniques may be employed to achieve this goal. One method situates the BU on the end of a cantilevered arm that acts as a spring. The arm provides some decoupling from the primary structure (headset or helmet). Another is a trampoline structure where the BU resides in the center and the perimeter is secured to the headset or helmet such that the contact force is repeatable – typically via a strap or cushion. A demonstrator assembly VBU-32500-000 is available as an example of a trampoline structure for evaluating performance. Contact Knowles field application engineering to request demonstrator and instructions.

VBU-32500-000

For general lightweight structures:

Examples – circuit boards, body panels, windows, medical, etc. Use BU without encapsulation to maintain low mass. It may be necessary to strengthen lead wire connections at terminals with epoxy. For use up to 5 kHz, double-sided tape is adequate for attach. Above 5 khz, may use cyanoacrylate adhesive or epoxy. At room temperature, beeswax is sufficient.

For machinery monitoring:

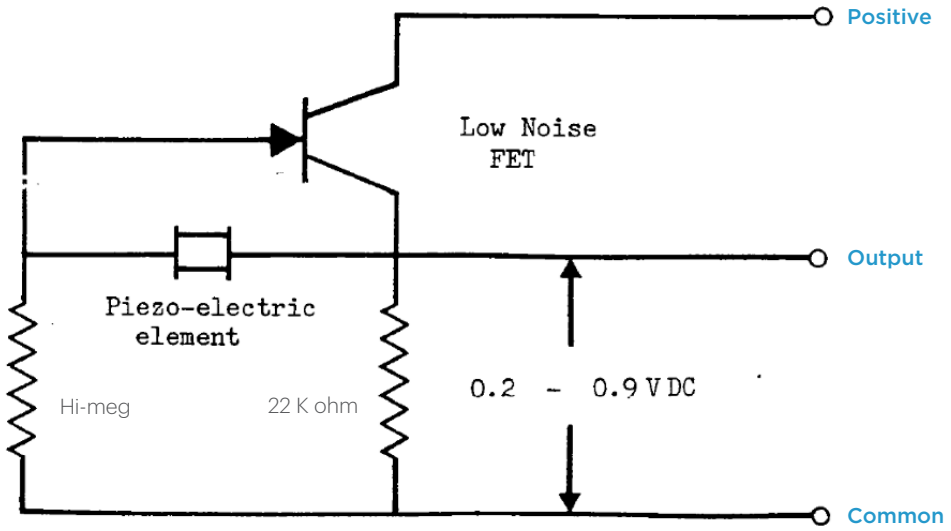
BU should be encapsulated in bubble-free epoxy within a metal housing to accommodate fastener. It is highly recommended that the source-follower mode is used for high accelerations. The external circuit components should be encapsulated along with the BU within secondary metal housing which may be earthed. The BU element in this application must be electrically insulated from the secondary housing.

EFFECTS OF TEMPERATURE

The BU will operate at 70°C with a nominal 1% increase in sensitivity. It may be stored at up to 120°C without permanent degradation (it will not operate at this temperature), but care should be taken to avoid rapid temperature changes because these may set up stresses in the piezo beam which will affect sensitivity.

ELECTRICAL

The ceramic piezo-electrical element is connected internally to a FET amplifier as shown below.



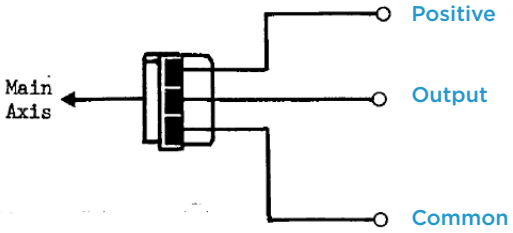
The case is connected to terminal 1 via resistance less than 1000 ohms. The transducer requires an external power supply which must be free of electrical noise. For the FET to operate, the voltage between terminals 1 and 3 must be greater than 1.1 V. It may be destroyed by voltages in excess of 20 V. The power input requirement is low, and may be supplied by a battery. The output impedance of BU depends on the mode of operation, but generally it is low enough to drive several feet of cable without special amplifiers.

The three common methods of use are:	
3-wire mode	Simple connection of DC supply across terminals 1 and 3, then output taken from terminal 2. This connection provides high sensitivity.
2-wire mode	Uses only terminals 1 and 3, for situations where only two connecting wires to the transducer are available
Source-follower mode	For measurements of high accelerations

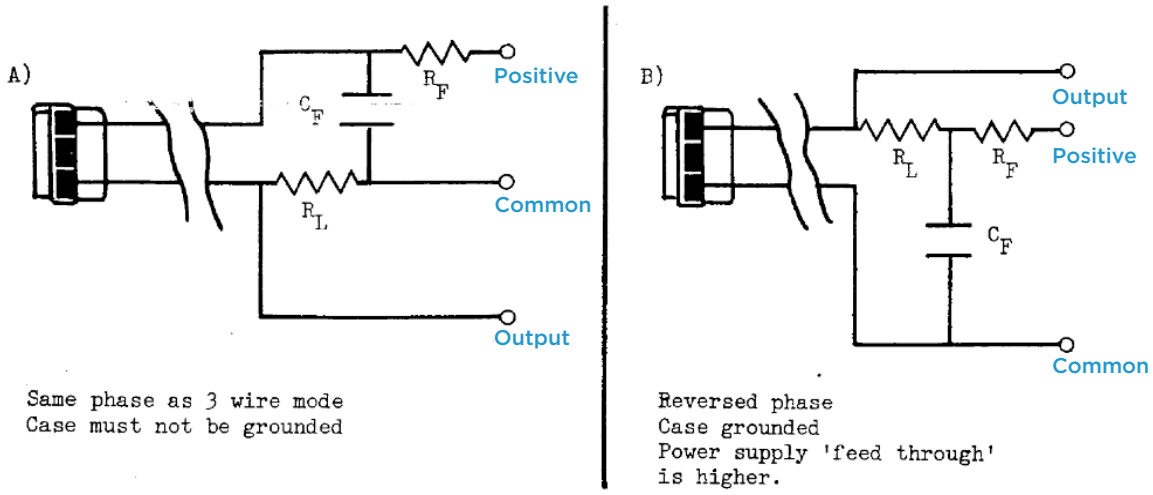
Some BU models are specified with 2-wire connection, some with 3-wire connection. Sensitivity and spread in sensitivity will change with different modes of operation.

3-WIRE MODE TYPICAL PERFORMANCE (FOR 1 G ACCELERATION AND NO MASS-LOADING OF ELEMENT)

- Supply voltage: 1.5 V DC (range 1.1 - 20 V).
- Current drain: 30 uA DC (range 20 – 50 uA)
- Output impedance: 13 k ohm (range 8 – 22 k ohm)
- Sensitivity: -37 dB re 1 V/g (about 14 mVrms)
- Typical minimum g: about 0.003 g for 6 dB S/N at 1 kHz
- Typical maximum g: about 10 g at 1 kHz / about 0.1 g at resonance
- Phase: acceleration in the direction of the arrow results in positive output



2-WIRE MODE TYPICAL PERFORMANCE (FOR 1 G ACCELERATION AND NO MASS-LOADING OF ELEMENT)



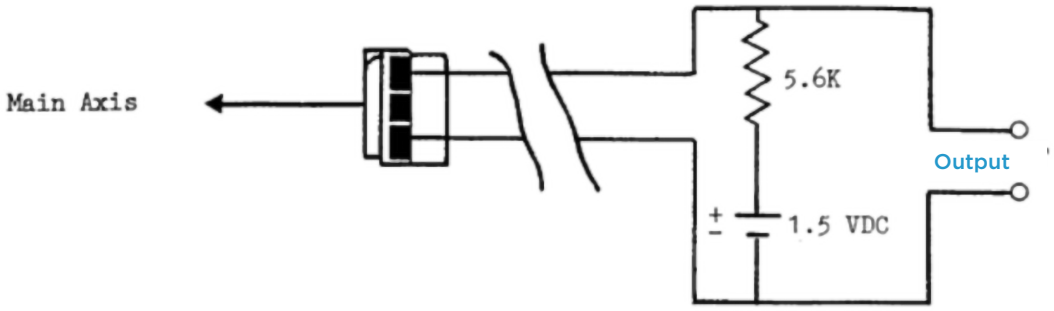
R_F < 2 k ohm, C_F > 1 uF, R_L < 20 k ohm (typically 4 k ohm)

A change to R_L will alter the sensitivity of the circuit.

R_F and C_F decouple the power supply and are not necessary if battery powered, or supply ripple is very low.

3-WIRE MODE TYPICAL PERFORMANCE (FOR 1 G ACCELERATION AND NO MASS-LOADING OF ELEMENT)

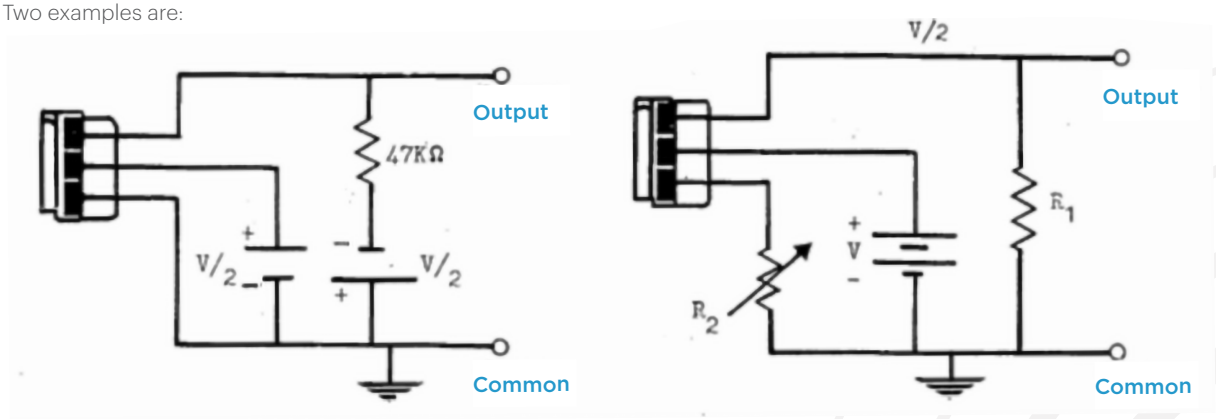
- Supply voltage: 1.5 V DC (range 1.1 - 20 V)
- Current drain: 30 uA DC (range 20 – 50 uA)
- Output impedance: 5.2 k ohm (range 4.9 – 5.5 k ohm)
- Response: see "Response" section of this note
- Sensitivity: -45 dB re 1 V/g (about 5.6 mVrms)
- Typical minimum g: about 0.003 g for 6 dB S/N at 1 kHz
- Typical maximum g: about 17 g at 1 kHz / about 0.17 g at resonance
    - For load resistor of 5.6 k ohm
- Phase: acceleration in the direction of the arrow results in positive output



SOURCE-FOLLOWER MODE TYPICAL PERFORMANCE (FOR 1 G ACCELERATION AND NO MASS-LOADING OF ELEMENT)

This method of connection overcomes the problem of electrically limiting the output due to the operating point of the FET amplifier.

Two examples are:



Dual Supply
(Case earthed)

Voltage Divider
(case not earthed)
Adjust R_2 until half of the DC supply volts appear at terminal 3. R_1 is typically 47 k ohm

FOR VOLTAGE DIVIDER HOOK-UP

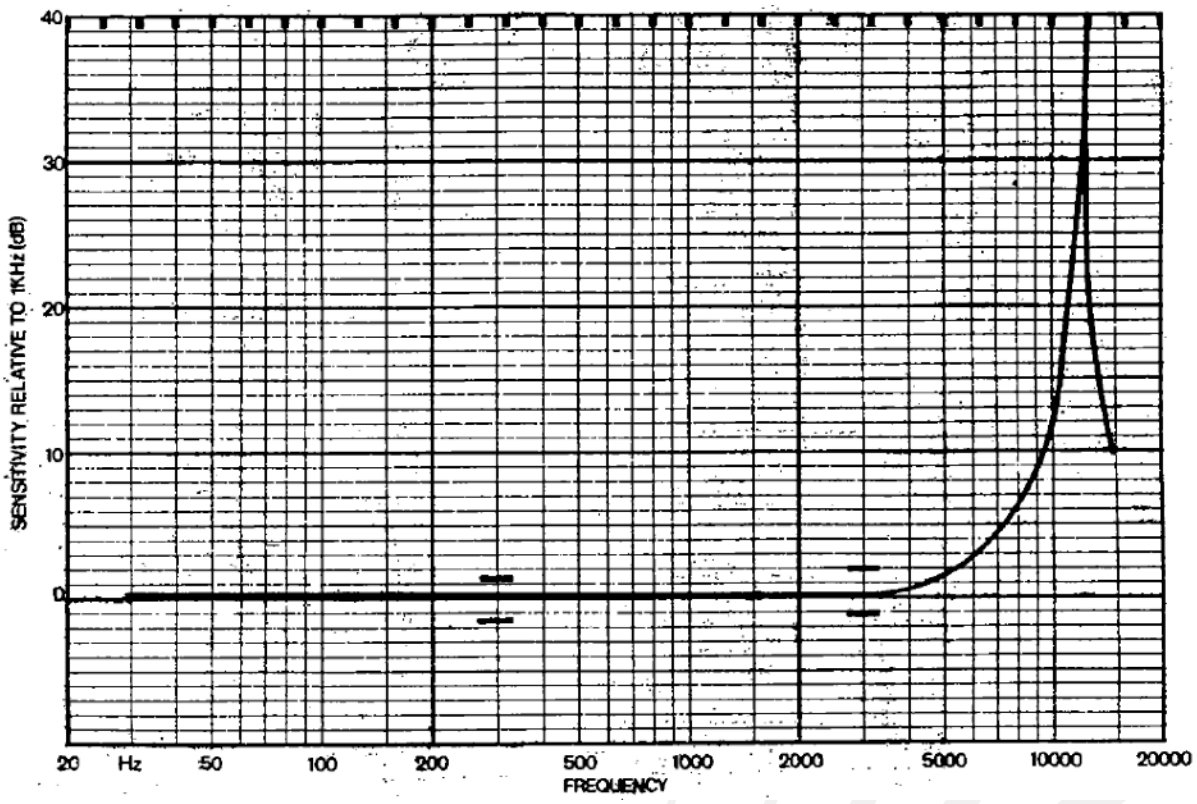
- Supply voltage: 20 V DC (range 1.1 - 20 V)
- R_1 = 47 k ohm
- When 10 V at terminal 3, R_2 ~ 20 k ohm
- Response: see "Response" section of this note
- Sensitivity: -45 dB re 1 V/g (about 5.6 mVrms)
- Typical noise from transducer ~7 uV, but take care with shielding as case is not earthed
- Typical maximum g: about 1780 g at 1 kHz / about 17 g at resonance

FREQUENCY RESPONSE

Typical response shape shown below for 2-wire mode.

Response conformity relative to 1 kHz actual sensitivity:

- +/- 1.5 dB at 300 Hz
- +2.0/-1.0 dB at 3 kHz



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Model/Reference Number:
TECHNICAL BULLETIN TB-26