CLAIMS:

1. A method for determining acceleration using as a linear function across the complete range of a vibrating beam accelerometer (10), having a pair of output electrodes (16, 16') wherein:

the vibrating beam accelerometer (10) can be modelled mathematically as a system having two beams (11, 11′) operating in a differential push-pull mode, such that each of the two beams vibrates at corresponding first and second frequencies of vibration (*f*+, *f*–) at which the respective amplitude (*A*+, *A*–) is dominant outside a lock-in zone within which the respective dominant frequencies (f_1, f_2) of the first and second beam are equal: and

the method comprises:

computing acceleration (Γ) within at least part of the complete range that includes the lock-in zone as a function, $A(\Gamma)$ such that:

$$A(\Gamma) = \frac{A_{1+}(\Gamma)}{A_{2+}(\Gamma)} - \frac{A_{2+}(\Gamma)}{A_{1+}(\Gamma)}, \quad \text{or}$$

$$A(\Gamma) = \frac{A_{2-}(\Gamma)}{A_{1-}(\Gamma)} - \frac{A_{1-}(\Gamma)}{A_{2-}(\Gamma)}, \quad \text{or}$$

$$A(\Gamma) = \left(\frac{A_{2-}(\Gamma)}{A_{1-}(\Gamma)} - \frac{A_{2+}(\Gamma)}{A_{1+}(\Gamma)}\right) - \left(\frac{A_{1-}(\Gamma)}{A_{2-}(\Gamma)} - \frac{A_{1+}(\Gamma)}{A_{2+}(\Gamma)}\right)$$

where:

$A_{1+}(\Gamma)$ and $A_{2+}(\Gamma)$ are the respective vibration amplitudes for Beams 1 and 2, corresponding to *f*+, and

$A_{1-}(\Gamma)$ and $A_{2-}(\Gamma)$ are the respective vibration amplitudes for Beams 1 and 2, corresponding to *f*–.

2. The method according to claim **1**, wherein:

the dominant frequency is lower than a crossover frequency at opposing boundaries of the lock-in zone where the respective dominant frequencies (f_1, f_2) of the first and second beam are equal; and

$A(\Gamma)$ is a function $A^+(\Gamma)$ of the amplitudes of vibration for both beams at respective dominant frequencies of vibration (*f*+) for each beam given by:

$$A^{+}(\Gamma) = \frac{A_{1+}(\Gamma)}{A_{2+}(\Gamma)} - \frac{A_{2+}(\Gamma)}{A_{1+}(\Gamma)}$$

where A_{1+} and A_{2+} are the vibration amplitudes of the respective beams as measured directly across the output electrodes.

3. The method according to claim **2**, wherein acceleration (Γ) is a solution to the following equation:

$$A(\Gamma) = k \cdot \Gamma$$

where: $A(\Gamma)$ is a function of the amplitudes of vibration for both beams at respective frequencies of vibration (*f*+) or (*f*–) for each beam, and

k is a constant.

4. The method according to claim **1**, wherein:

the dominant frequency is lower than a crossover frequency at opposing boundaries of the lock-in zone where the respective dominant frequencies (f_1, f_2) of the first and second beam are equal; and

$A(\Gamma)$ is a function $A^{-}(\Gamma)$ of the amplitudes of vibration for both beams at respective sub-dominant frequencies of vibration (*f*–) for each beam given by:

$$A^{-}(\Gamma) = \frac{A_{2-}(\Gamma)}{A_{1-}(\Gamma)} - \frac{A_{1-}(\Gamma)}{A_{2-}(\Gamma)}$$

where A_{1-} and A_{2-} are the vibration amplitudes derived indirectly by further processing of the signals across the output electrodes to isolate the sub-dominant frequency component of the output signal.

5. The method according to claim **4**, wherein acceleration (Γ) is a solution to the following equation:

$$A^{-}(\Gamma) = k \cdot \Gamma$$

where: $A^{-}(\Gamma)$ is a function of the amplitudes of vibration for both beams at respective sub-dominant frequencies of vibration (*f*–) for each beam, and

k is a constant.

6. The method according to claim 3 or 5, wherein the constant *k* is given by:

$$k = \frac{2M\lambda}{M_0}$$

where: M is the mass of the seismic mass,

$M_0 = \frac{m_0 M}{M+m_0}$,

m_0 is the mass of each beam, λ is a scale factor such that $k^{\pm}(\Gamma) = k_0(1 \pm \lambda\Gamma)$,

k_0 is the spring stiffness at acceleration = 0, and

$k^{\pm}(\Gamma)$ is the spring stiffness at acceleration = Γ.

7. The method according to claim **1**, further including determining acceleration outside of the lock-in range as a function of differential frequency *Δf* equal to a difference in respective measured dominant frequencies for each beam.

8. The method according to claim **7**, including:

(a) subjecting the accelerometer to an acceleration and measuring the respective dominant frequency of vibration (f_1, f_2) for each beam;

(b) if the dominant frequency exceeds a predetermined crossover frequency at opposing boundaries of a predefined range that includes the lock-in zone:

i) measuring a corresponding differential frequency *Δf* equal to a difference in the respective measured dominant frequency for each beam; and

ii) determining acceleration (Γ) from the measured differential frequency *Δf* and a pre-calibrated frequency-acceleration characteristic.

9. The method for determining acceleration according to claim **8**, wherein the pre-calibrated frequency-acceleration characteristic is a linear function.

10. The method according to claim **9**, wherein the linear function is:

$$\Delta\omega \approx \lambda \sqrt{\frac{k_0}{m_0}}\Gamma$$

where: ω=**2**π*f*,

Δf = measured frequency difference;

Γ = acceleration;

m_0= mass of each beam;

k_0= stiffness of each beam; and

λ = a known scale factor.

11. The method according to claim **1**, wherein acceleration Γ inside said range is a solution to the following equation:

$$A(\Gamma) = \frac{4M\lambda}{M_0}\sum_{n=0}^{\infty}\lambda^{2n}\Gamma^{2n+1}$$

where: M is the mass of the seismic mass,

$M_0 = \frac{m_0 M}{M+m_0}$,

m_0 is the mass of each beam,

λ is a scale factor such that $k^{\pm}(\Gamma) = k_0(1 \pm \lambda\Gamma)$,

k_0 is the spring stiffness at acceleration = 0, and

$k^{\pm}(\Gamma)$ is the spring stiffness at acceleration = Γ.

12. The method according to claim **11**, wherein $\lambda\Gamma \ll 1$ and acceleration Γ inside the predefined range is an approximate solution to the following equation:

$$A(\Gamma) = \frac{4M\lambda}{M_0}\Gamma$$

13. The method according to any one of claims **1** to **12**, further including calibrating the vibrating beam accelerometer by:

i) obtaining for each of the beams a respective pair of amplitude-acceleration characteristics by subjecting the accelerometer to a range of known accelerations and measuring corresponding signal amplitudes at each acceleration such that for each beam there are corresponding first and second frequencies (f–, f+) at which the respective amplitude is dominant at different accelerations throughout said range; and

ii) determining respective crossover points for each beam where at each crossover point the respective amplitudes ($A–$, $A+$) at both the first and second frequencies ($f–$, $f+$) are the same.

14. The method according to any one of claims **1** to **12**, further including calibrating the vibrating beam accelerometer by:

i) subjecting the accelerometer to a range of known positive and negative accelerations such that for each beam there are corresponding first and second frequencies ($f–$, $f+$) one of which is dominant and one of which is sub-dominant;

ii) for each known acceleration measuring the respective dominant frequency of each beam; and

iii) determining the respective crossover points at which the dominant vibration frequencies of the two beams are equal and the absolute values of positive and negative accelerations for both beams are maximum.

15. The method according to any one of claims **1** to **12**, further including measuring the respective dominant vibration frequencies of the two beams, and establishing that acceleration is inside the lock-in zone when the measured frequencies are equal for both beams.