Elasticated Chest/Abdomen Strap with Piezo Film Sensor

R H Brown 4 Sept 2000

Sensor: an example of a shielded piezo film element (originally produced in limited quantity as a guitar pick-up) was used. The active sensor area was approximately 100 x 18.5 mm, but the sensor comprised a long single film, folded over at its midpoint, and glued to form a sandwich with the outer conductive electrode being connected to ground. A short length of coaxial cable was fitted, and the area where this cable was connected to the film element was carefully shielded with copper foil. The entire lead attachment area was encased in a thin, rigid plastic housing (approx 30 x 30 mm). Capacitance of the sensor (including cable) was 6.2 nF.

Strap: a 30 mm elasticated fabric strip, stitched together to form a continuous loop (originally the waistband of a pair of undershorts).

The sensor was fixed to the elastic strap by a length of 25 mm wide double-coated adhesive tape, running the full length of the piezo sensor including the rigid lead-attach housing. Ideally, the film element could be sewn into the fabric along its edges. Although the adhesion of the acrylic tape was not perfect, the sensor remained attached to the fabric, apparently without slippage, for the duration of the tests.

Instrumentation: the sensor was connected to a modified B&K 2635 Charge Preamplifier. The modification allows the selection of 2 Hz, or 0.02 Hz, lower limiting frequency. B&K quote the LLF as the –10% frequency: note that the attached graphs use the more common definition of LLF as –3 dB frequencies (1 Hz and 0.01 Hz respectively). The charge amp was set to a sensitivity of 100 mV/nC. Given the sensor capacitance of 6.2 nF, this results in an effective open-circuit voltage gain of 0.62X. Signals were captured on a HP3561A dynamic signal analyzer and saved to disk.

The elasticity and comfort of the strap allowed its use as either a chest or abdomen strap. Depending upon the type of breathing, the relative amplitudes of chest or abdomen motion could vary, but in general terms the levels were similar. Useful phase information could possibly be gathered using one such strap in each location simultaneously, but this experimental set-up did not allow such testing.

Initially, the lowest frequency setting available on the charge preamplifier (0.01 Hz) was used. This gave peak-to-peak amplitudes (from shallow breathing) of around 300 mV. Much deeper breathing could increase this to > 1 V. Superimposed on this breathing signal (from both mounting locations) was a pulse signal, 10 to 20 times weaker in amplitude.

The attached plots show the full low frequency waveforms for shallow breathing at both locations (NB: not measured simultaneously), enhanced detail of pulse signals obtained by increasing the LLF to 2 Hz and zooming in Y-scale, and a single FFT trace corresponding to the full bandwidth abdomen signal, where both breathing and pulse rates may be seen. Note that the pulse signal here also happens to be an integer multiple of the breathing frequency, and so its amplitude may be somewhat greater than in the absence of breathing.

Conclusion: a shielded piezoelectric film sensor may be used in conjunction with an elasticated strap to detect breathing and heart rate signals at both chest and abdomen.

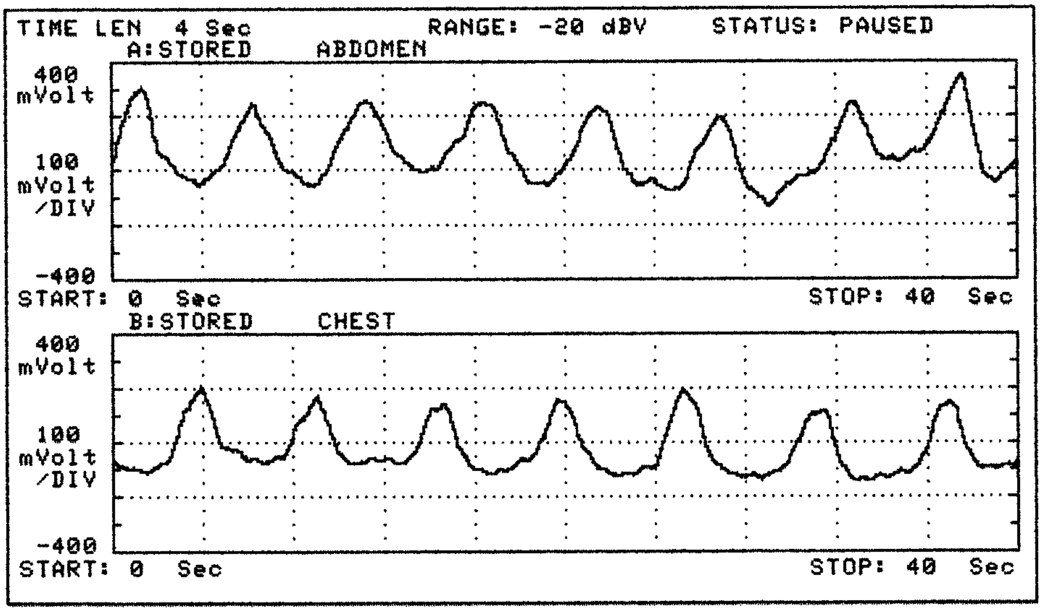

Figure 1: Breathing signals at around 12/min (using 0.01 Hz LLF)

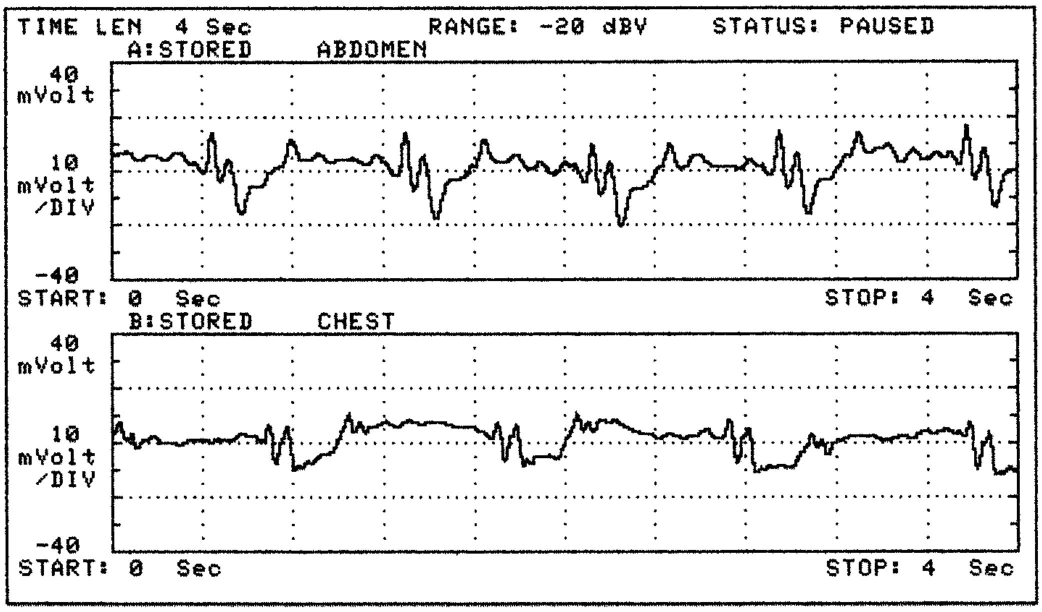

Figure 2: Pulse signals at around 60/min (using 1 Hz LLF)

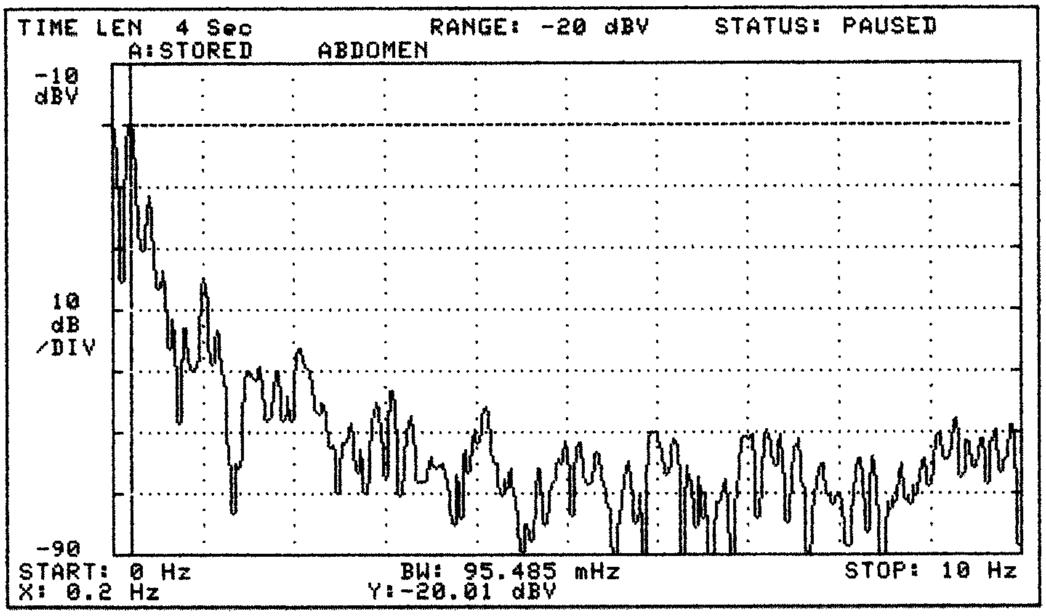

Figure 3: FFT of abdomen signal (LLF 0.01 Hz), showing breathing & pulse spectral components (0.2 Hz and 1.0 Hz)

Distribuidor

Brasil e América do Sul

CONTATO

Endereço
Rua Sete de Setembro, 2671 - Centro
13560-181 - São Carlos - SP - Brasil

Telefone
+ 55 (16) 3371-0112

Fax
+ 55 (16) 3372-7800

Internet
www.metrolog.net
metrolog@metrolog.net

Metrolog Controles de Medição