SLEEP MONITOR STRIP

Features

Very low thickness, imperceptible on mattress

High open-circuit voltage sensitivity to dynamic strain

Can detect breathing, pulse and body movement

Ballistocardiographic (BCG) principle

Applications

heart rate, heart rate variability, respiration rate measurements

Description

The sleep monitor strip is a strip of Piezo film (piezoelectric PVDF polymer) 800mm long and 8mm wide. The active electrode area is 698.5mm long and 3mm wide. The total thickness of the strip is around 50 microns, making it extremely flexible and entirely imperceptible when placed under the body. Electrical interconnection is made via two crimped solder tabs. The strip produces a charge or voltage output when subjected to dynamic strain (change in length). When mounted across a mattress in line with the chest/heart, the strip can detect heart sounds, tiny changes in load or center of gravity due to breathing. These signals may then be assessed over an extended time period (e.g. overnight) and may be indicative of duration, phase, or quality of sleep.

The sensor requires no external power and is therefore suitable for use with battery-operated equipment where power consumption must be kept to a minimum.

Typical properties

Parameter	Min	Typ	Max	Units/condions
Overall length	797.5	800.0	802.5	mm, excluding solder tabs
Overall width	7.7	8.0	8.3	mm
Active electrode length	691.5	698.5	701.0	mm
Active electrode width	2.7	3.0	3.3	mm
Capacitance	5.4	7.3	9.3	nF@1k Hz
Dissipation Factor	-	0.02	0.03	@1k Hz
Strain Sensitivity (V)	-	0.015	-	V/με
Strain Sensitivity (Q)	-	110	-	pC /με
Base film thickness	27	30	33	μm
Yield stress	45	-	-	MPa (stretch direction)

Typical response

(on top of mattress, under mattress protector)

0.1 Hz data	Q p-p	V p-p OC
Pulse	0.5-1 nC	75-150 mV
Breathing	2-7 nC	0.3-1 V
Movement	100-500 nC	10-70 V

Notes on typical response

Peak-to-peak charge (Qp-p) and voltage into open-circuit conditions (Vp-p OC) are shown as a very general guide only. Signal levels may be affected by the compliance of mattress, thickness and material of bed linen, occupant's posture/ orientation on the bed, body shape, physique and health, and many other factors.

Interface requirements

As with any piezoelectric sensor, the low frequency response of the sleep monitor strip is set by the external circuit to which the sensor is connected. Under true open-circuit conditions, the leakage of charge through the piezo dielectric material is minimal, and the low frequency response extends close to DC (< 1m Hz). In practical terms, it is necessary to define a functional limit to avoid long-term drift and potential slow but high-amplitude signals resulting from the pyroelectric response of the film. Adult respiratory rate is generally taken as falling in the range 12 to 18 breaths/minute, although this may reduce during sleep. To capture breathing signals, it is important to use the sensor with an electronic network that has suitable low frequency response.

The Piezo film lab amplifier (TE Part # 1007214-X) offers a selectable lower limiting frequency of 0.1 Hz, which is useful in this case. In addition, an upper limiting frequency of 10 Hz can be set, which eliminates unwanted 50/60 Hz mains (line) interference. A wide range of overall gain is offered, and the Amp may be operated either in charge mode or in voltage mode.

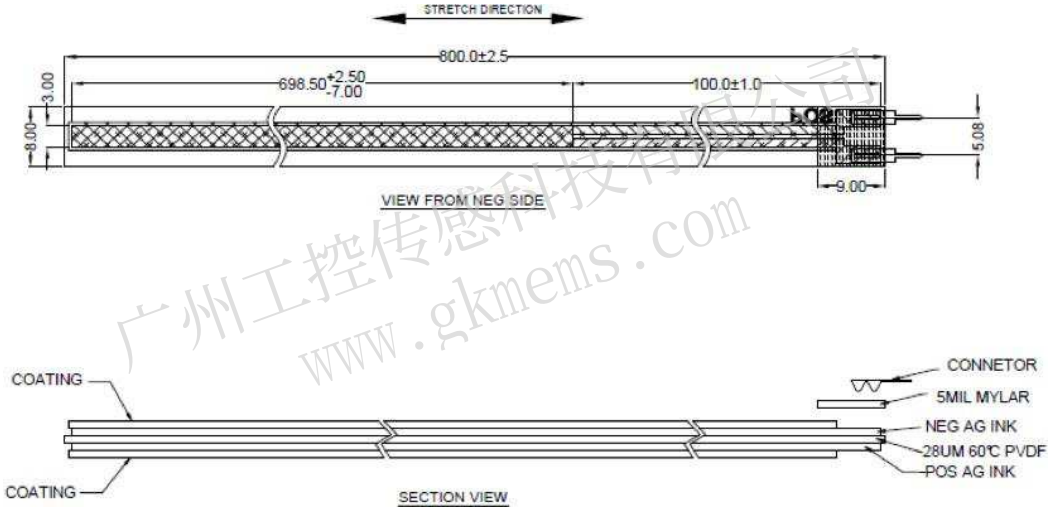
Direct connection of the sleep monitor strip to a conventional oscilloscope input (with 1M input resistance) is not recommended, as this will form a high-pass filter with cut-off frequency (to -3dB) at approximately 22 Hz. This will significantly attenuate the target signals arising from breathing or pulse.

To obtain a response to 0.1 Hz (-3dB point) with a simple voltage-mode circuit, an input resistance of 220M is required.

If only heart rate is required (and not respiratory rate), then a lower limiting frequency in the range 1 – 3 Hz may be sufficient.

If an interface circuit is constructed that allows successful detection of pulse signals, then this is very likely to become saturated when gross bodily movement occurs, with up to 500X higher signal level. If the circuit is also set up to detect breathing with a response down to 0.1 Hz, then the effect of saturation and/or time constant settling may cause up to 30s interruption of detection of pulse & breathing after body movement occurs.

Dimensions



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