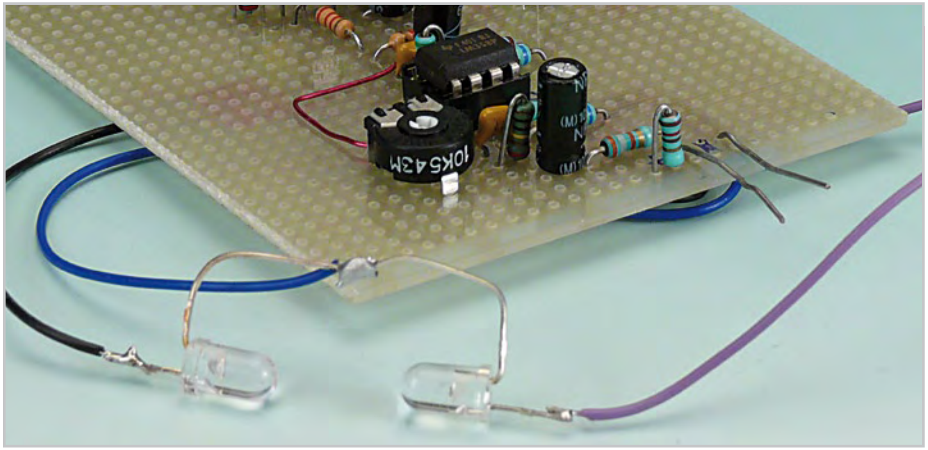
Stress-o-Meter

Markus Bindhammer (Germany)



The common meaning of the term ‘stress’ is distinctly different from what specialists understand by the term, and even they disagree with each other. The Wikipedia entry for this term [1] gives an impression of its complexity. Consequently, it’s a good question whether it is even possible to measure stress. However, it is certainly possible to measure how our bodies respond to stress.

No matter whether something is especially pleasant or instead triggers anxiety or aggression, if there is a strong stimulus, our bodies are prepared to act accordingly. Jumping for joy, fleeing, and attacking all cost a lot of energy. One the many consequences is thus an increase in the heart rate, which is probably the most easily measured response to stress.

The resting heart rate of a healthy person is around 50 to 100 beats per minute (bpm). A person’s pulse can be measured either electrically with an ECG instrument or by sensing the periodic variation in blood flow through the body tissue. The first method requires electrical contact between electrodes and the skin, which is not especially advisable for DIY electronics. By contrast, the variation in blood flow can easily be sensed using light transmission, since the absorption of the transmitted light depends on the blood flow. Ear lobes and fingertips are especially suitable for light transmission measurements.

The author converted an ordinary plastic clothespin into a finger or ear clip. To do so, he first drilled a 5-mm hole in each arm of the clip and then glued an IR LED (type SFH487) in one hole and a phototransistor (type SFH309FA) in the other hole (see drawing). A bright red LED or even a white LED can be used in place of the IR LED. It’s even possible to use an LDR as the photosensor. Ready-made clips are also available commercially as medical accessories (expensive) or accessories for ergometers and similar sports equipment (inexpensive).

With a 5-V supply, the current through the IR LED is around 30 mA. The sensor signal (with its small voltage variations) passes through a high-pass filter (C1/R3), which removes slow drift, to the non-inverting input of opamp

IC1a. The combination of C2 and R5 forms a low-pass filter that decouples high-frequency noise. IC1a amplifies the signal in the passband, which is centred at 100 bpm, by a factor of 100. A similar combination of filter and amplifier is built around IC1b, in this case with a gain of 500. The LM348 dual opamp is especially suitable for this circuit because it can handle small-signal inputs close to 0 V, even when powered from a single-ended supply. The overall gain of the two stages can be adjusted with P1. The output of IC1b drives T2 and T3 in parallel, so D2 blinks at the same rate as the variation in blood flow through the ear or finger between D1 and T1.

The ‘excess rate’, or stress, is indicated by IC2, a conventional 555 timer IC. Transistor T3 shorts out capacitor C6 when D2 is on. This resets the internal flip-flop of the 555 and causes pin 3 to go High, which in turn causes D4 to light up. When D2 is off, C6 can charge via R12. If the charging interval is long enough for the voltage on C6 to rise to two-thirds of the supply voltage, the output of the 555 changes state, LED D4 goes dark, and D3 flashes briefly. This means that the user’s pulse rate is low as long as D3 blinks periodically. C6 and R12 are dimensioned such that D3 remains dark at heart rates above 100 bpm.

For safety reasons, an AC mains adaptor should not be used as the power source. The circuit works properly with a supply voltage of 4.5 to 7 V, so a set of four alkaline, NiCd or NiMH cells forms a perfectly adequate power source.

(080831-I)

Internet Link

[1] http://en.wikipedia.org/wiki/Stress