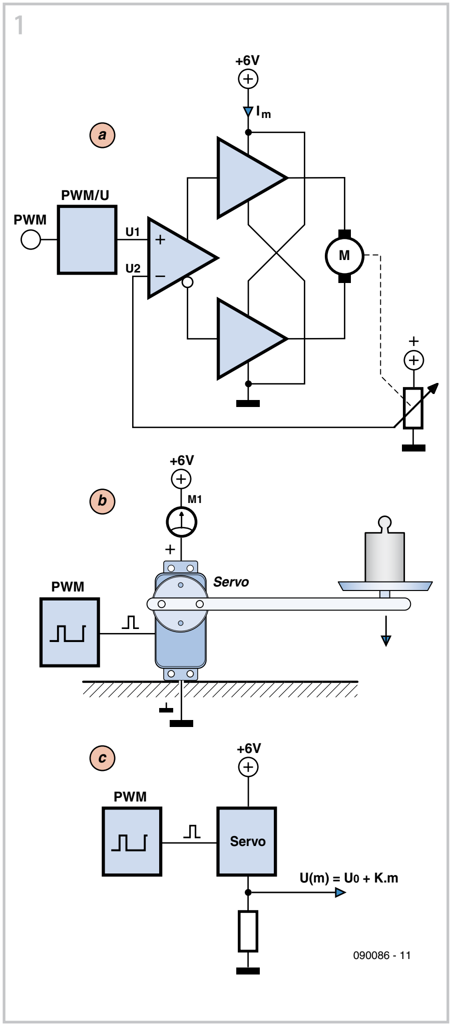
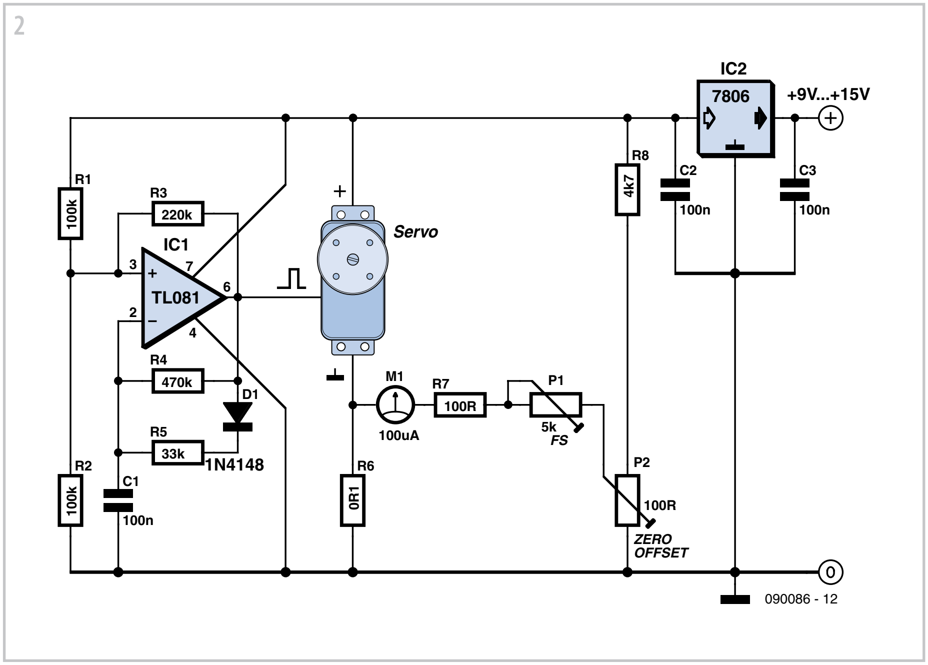
Servo Scales





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With a bit of adeptness, you can build an electronic scales based on a servo motor. Depending on the type of servo you use, it can measure weights of up to around five kilograms (11 lbs) with reasonable accuracy.

If you examine the operating principle of a servo motor in more detail (**Figure 1a**), you can see that in simple terms, it consists of a control loop that uses a potentiometer to convert the motor position to a voltage that is compared to the voltage from a PWM converter. Based in this information, the motor is rotated so that its measured position corresponds to the desired position (U2 = U1).

As can be seen from **Figure 1**, all you need for a scales based on a servo motor is a square-wave oscillator that supplies a signal at a constant frequency of around 50 Hz with a fixed duty cycle of approximately 10%. This defines a fixed setting for the position of the motor axle. If a mechanical force tries to rotate the motor axle in this situation, the servo control loop adjusts the drive signal to the motor to counteract the rotational force. The motor thus has to supply an opposing force, and that costs power, with the result that the current through the motor increases. With a type RS-2 servo, this current can rise to as much as 1 A, while the quiescent current is no more than a few dozen milliampères. If you attach an arm to the motor axle and fit it with a weighing pan, and then connect an ammeter in the servo supply line, you have a sort of simple electronic scales. The scales can be calibrated using a reference weight, with the length of the arm set to produce a certain amount of current with a certain weight, such as 0.5 A with 1 kg. Two kilograms would then draw 1 A, and so on.

The scales can also generate a voltage output if you measure the voltage across a sense resistor in series with the ground lead of the servo (**Figure 1c**). Due to the quiescent current consumption of the servo motor with no load, this voltage is not zero with no weight on the scales, but it is low compared with the value with a certain amount of weight. Naturally, this offset can be compensated by using an instrumentation amplifier. This increases the accuracy, and you could even consider equipping the scales with a digital readout.

Figure 2 shows a simple finished version with a PWM oscillator and analogue readout. The two potentiometers can be used to adjust the offset and weighing range. The length of the scale arm multiplies the torsion on the servo motor due to the weight. Doubling the arm length reduces the weighing range by half and thus doubles the accuracy, but it also increases the zero offset due to the weight of the arm. In practice, an arm length of around 10 cm proved to be a good compromise.

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