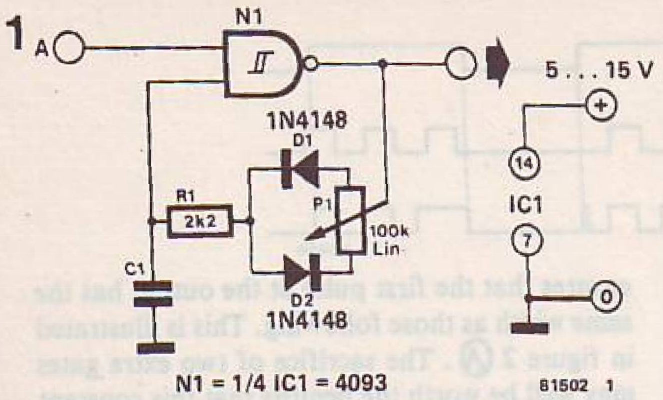
1



meter, one of the four gates can be used to produce an oscillator with a set frequency and a variable duty-cycle. The pulse duration is determined by the RC time-constant of the network consisting of capacitor C1 and resistors R1 + P1. When the wiper of the potentiometer is in the mid position a perfectly symmetrical squarewave signal is obtained at the output. If, however, the setting of P1 is altered, the capacitor (C1) will take a different time to charge than to discharge. As a result, gate N1 will be triggered either sooner or later on either the positive-going or negative-going edge of the signal depending on the direction in which P1 was rotated. This effectively means that the pulse width varies.

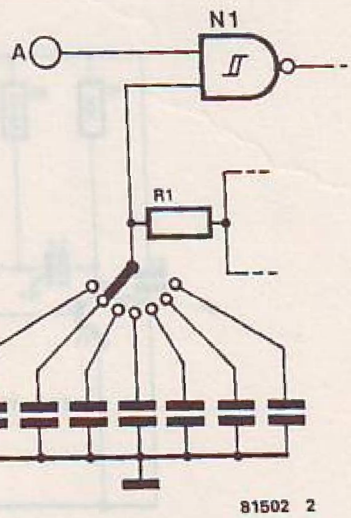
As far as R1 is concerned, this acts as a protective measure in case P1 is turned fully clockwise (minimum resistance). This means that the duty-cycle is not 100% variable, but, after all, a 2... 98% range should be perfectly acceptable!

The frequency of the oscillator is dependent on the value of capacitor C1, since the sum of the RC time-constants is the same for both half-periods. If several different frequencies are required, a multiway switch with a corresponding number of capacitors may be included to replace C1 (see figure 2). This enables the pulse duration to be varied in stages.

Using the control input (A) the entire unit can be incorporated in a logic circuit. If the input voltage is logic zero, the output will be logic one; if, however, the input level is logic one, the oscillator will start to operate. If the control input is not required, this may be omitted by either linking the input to the junction of R1/C1 or to the positive rail of the power supply (logic one).

Although the edge of the output pulse is fairly steep already, it can be further improved by connecting one of the other gates in the same IC to the output. The second gate will then act as an inverter.

2

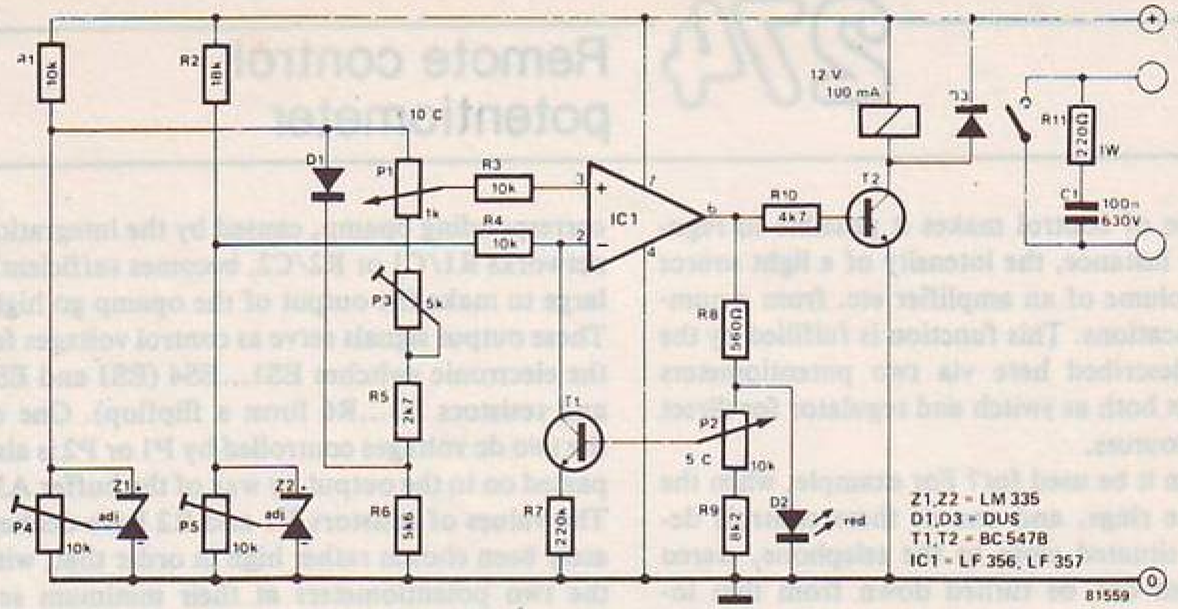


273 Differential switch

There is virtually no doubt that interest in this particular circuit will increase as the price of electricity – and of energy in general – continues to rise. The differential switch is able to measure the difference in temperature between two points and, depending on the temperature difference, it will switch a relay on or off. The relay can then be used, for example, to activate a circulation pump. There are numerous applications for the circuit. It can be used in combination with solar heating panels or solar collectors and it can also be used to control the pump in central heating systems. In the latter case, one sensor is placed in the return pipe while the other is situated in the hot water outlet pipe close to the boiler. As soon as the boiler switches on, a temperature difference is created and the pump also switches on.

The attractive feature of this design is the fact that both the temperature difference and the hysteresis of the unit can both be set independently, so that they do not affect each other. Moreover, the adjustments are virtually linear, therefore the potentiometer settings can be relied on to give consistent results. A LED has been included in the circuit to give an indication of when the relay is actually on.

The temperature sensors are two LM 335s

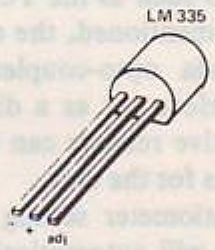


(National Semiconductor). This IC can be looked upon as being a zener diode whose voltage increases by 10 mV per °C. Therefore, at room temperature the zener voltage is equal to: (273 + 20) x 10 mV = 2.93 V.

The temperature transducers incorporate calibration connections, which make it possible to set the output voltage (at 20 °C) to the value mentioned above. In the same way, undesirable differences between the sensors can be corrected. It is also possible to disregard the adjustment input of one of the sensors (by not connecting it) and to adjust the other sensor to give the same characteristics as the first. This can make construction and setting up considerably simpler.

The principle of operation is as follows: The voltages from the two sensors are directly compared by IC2. When the temperature – and thus the voltage – of Z1 becomes greater than that of Z2, the output of IC2 goes high lighting LED D2 and activating the relay via transistor T2. If potentiometer P1 has not been turned fully up, a higher input voltage is required to operate the comparator and the relay will therefore be activated at a higher temperature difference. There is a potential drop of about 0.6 V across diode D1. Approximately 100 mV of this remains across P1 (the actual voltage drop across P1 can be adjusted by means of P3). The 100 mV corresponds to about 10°C, so in effect P1 can be adjusted over a range of 10°C. Sensor Z1 must therefore be 10°C warmer than Z2 with P1 at the lowest setting in order to activate the relay.

Once the pump has been switched on by the relay, the temperature of the sensor close to the boiler will drop due to the circulation of the water. This could result in the circuit switching itself off almost immediately. Obviously, this



situation is undesirable and for this reason potentiometer P2 has been included to adjust the amount of hysteresis by a maximum factor of 5°C. With P2 set in the centre position the circuit has a hysteresis of 2.5°C. This means that if P1 has been set to, say, 5°C, the relay will be activated when the temperature difference reaches 5°C, but will not turn off until the difference in temperature is 5°C – 2.5°C = 2.5°C.

LED D2 should be a red one with an operating voltage of about 1.3 V. The supply voltage for the circuit is not critical and can deviate by a few volts. The circuit diagram shows a supply voltage of 12 V because relays operating at this voltage are readily available. Transistor T2 is only allowed to dissipate a maximum of 100 mA and for this reason the current rating of the relay should not exceed this value.

The actual temperature at which the circuit operates can be calculated from the voltage across Z1 and Z2, if a thermometer is not available.