AUTOMATIC POLARITY CHANGEOVER FOR MULTIMETERS

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Wherever a number of DC voltages have to be measured with a multimeter in a circuit, one has to either frequently interchange the probes or operate a switch to take a proper reading on the meter. This nuisance can be removed easily. The easier of the methods is, however, not very satisfactory.

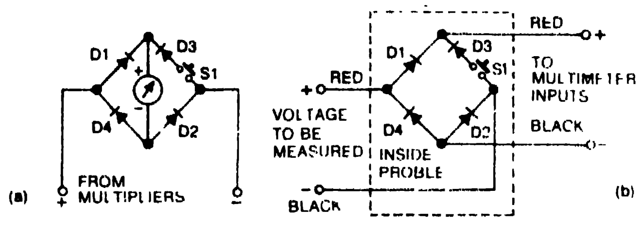

Fig. 1: A simple method of automatic polarity changeover.

A simple metho-

The easiest way to overcome this problem is by inserting a bridge rectifier either within the meter or at the input to the multimeter. The rectifier will take care of the polarity in either case, as shown in Figs 1(a) and 1(b). Both these circuits perform the same functions. The push-to-open switch fitted to one arm of the bridge gives an indication of the polarity.

The circuit shown in Fig. 1(a) can be wired inside the multimeter itself while the circuit shown in Fig. 1(b) may be wired in a special DC probe housed in the body of a miniature pen torchlight. When a voltage is applied, the meter's pointer deflects in the proper direction, irrespective of the input polarity.

Germanium point contact diodes with a low forward drop and low leakage should be used in the circuit shown in Fig. 1(a) while silicon diodes of high PIV rating should be used in the case of circuit shown in Fig. 1(b). In both cases, all the diodes must be matching.

On pressing the push-button switch S1, if the meter continues to read it indicates that the current is flowing through D1 and D2 and that the voltage is of positive polarity. If the meter reads zero when S1 is pressed, it indicates that the current was flowing through D3 and D4 and was interrupted by the opening of S1. This means that the polarity of the input voltage is negative.

Both these circuits, however, suffer from a serious drawback. They affect the meter's calibration and also the linearity of its scale because of the non-linear characteristics of the diode. This effect is more pronounced in the low-voltage range, where the input voltage is near the forward conduction voltage of the diode. The readings, therefore, can no more be accurate.

Another disadvantage of these circuits is that a switch has to be pressed to know the polarity.

The circuit shown in Fig. 1(a) affects all the ranges in the same fashion because it is connected after the multipliers. Therefore, the meter can be recalibrated for correct readings. The scale cannot be made linear, however.

The circuit of Fig. 1(b) behaves in a different way. Here the bridge is wired inside a special DC probe. The diodes used must have a voltage rating equal to that of the maximum voltage to be measured. Here the effect of the bridge will be notable only in the low-voltage ranges. In the higher voltage ranges the diode drop is negligible when compared to the measured voltage. So this configuration can be used in a multimeter without altering the calibration in the

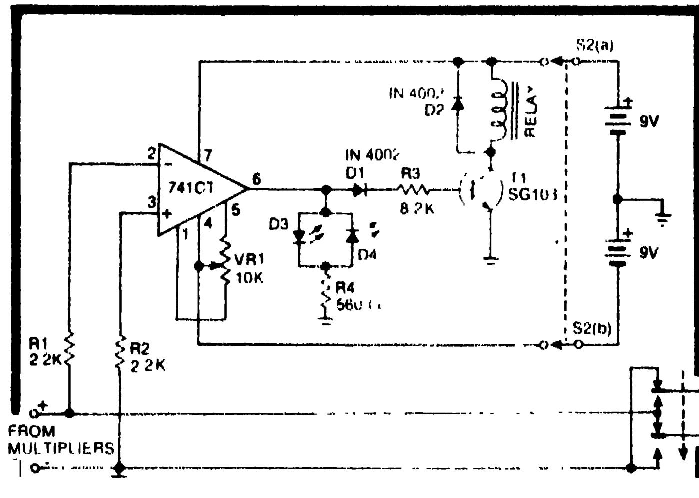

Fig. 2: The automatic polarity changeover with indicator.

higher ranges. Of course, the accuracy and linearity of the scale will deteriorate in the lower ranges.

The automatic polarity changeover circuit

A circuit which in no way affects the calibration or linearity of the meter is shown in Fig. 2. Another advantage of this circuit over the previous two circuits is that it can be switched off when not required and the multimeter can be used as usual. Moreover, it consumes very little power when the relay is not energised.

The circuit senses the polarity of the voltage to be measured and operates a relay in such a way that the voltage fed to the moving coil unit is of the correct polarity. The unit also gives an indication of the polarity.

The circuit

The input stage of the circuit shown in Fig. 2 consists of an operational amplifier (CA 741 CT) in the open loop mode, which works as a switch. It senses the polarity of the voltage to be measured and gives an output corresponding to the polarity.

The connections to the moving coil unit of the multimeter are made through the relay The same meter inputs are connected to the IC. The inverting input (pin no. 2) is connected through R1 to the line going to the positive terminal of the meter. The non-inverting input (pin no. 3) is grounded through R2. The negative line going to the meter is also grounded.

Transistor T1 energises the relay when the opamp output is positive. Diode D2 bypasses the high surge voltages developed across the relay coil and prevents them from damaging the transistor. Diode D1 allows only positive voltage to pass to the base of T1, and it also provides a higher threshold of switching. D3 and D4 are LEDs which give an indication of the polarity. R4 limits the current passing through the LEDs. The split rail power supply for the opamp is obtained by using two 9 V energiser batteries.

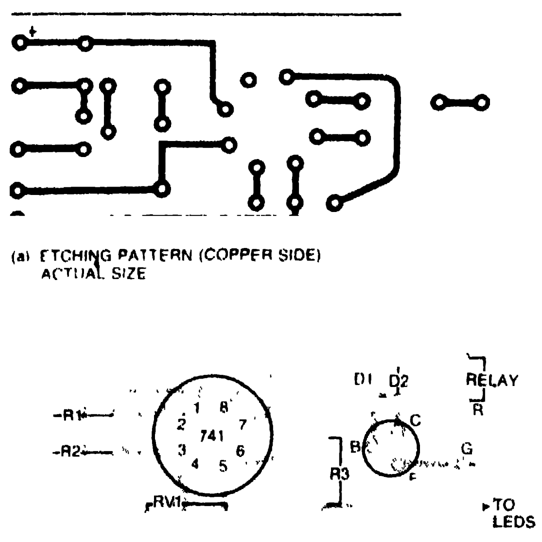

Fig. 3: Printed circuit pattern (a) and components layout (b).

Working

When the voltage being measured is of positive polarity, the plus rail to the moving coil unit will be positive and the minus rail will be negative. This makes the inverting input of the opamp positive with respect to the non-inverting input. The opamp output now switches to -9V and T1 remains cut off. The connections to the moving coil unit are now made through the N/C contacts of the relay and the meter reads as usual. Since the output of the opamp is -9V, LED D4 (red) lights up, indicating a positive voltage.

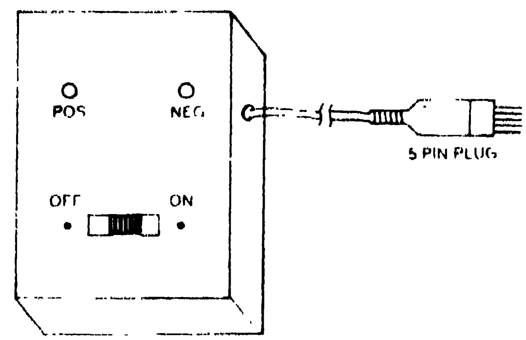

Fig. 4: Cabinet mounting.

Now if the voltage being measured is negative, the inverting input of the opamp is negative with respect to the non-inverting input and the opamp output swings to + 9V switching on transistor T1. The relay is now energised and the connections to the moving coil are reversed (i.e. through the N/O contacts). Since the output of the opamp is now + 9V, LED D3 (green) lights up, indicating a negative voltage.

Since only the relay contacts are included in the meter's circuit, the calibration or linearity of the meter is not at all affected. The input impedance of the opamp is very high (between 1 megohm and 10 megohm). Therefore, this also does not affect the meter's calibration.

Construction

The whole unit can be mounted in a plastic box. The PCB pattern and layout is shown in Fig. 3. The relay, battery and the wired PCB is placed inside the box. The LEDs can be fixed to the box with 'Araldite' or 'Quickfix.' The connections to the multimeter can be made directly or with a 5-pin DIN socket and plug, as shown in Fig. 4.

Adjustments

After the circuit is wired, it should be checked thoroughly for proper connections and polarities (preferably by someone else). Offset adjustment of the opamp can then be made by grounding pin nos 2 and 3, and adjusting VR1 for zero voltage at pin no. 6. The circuit is now ready for use. □