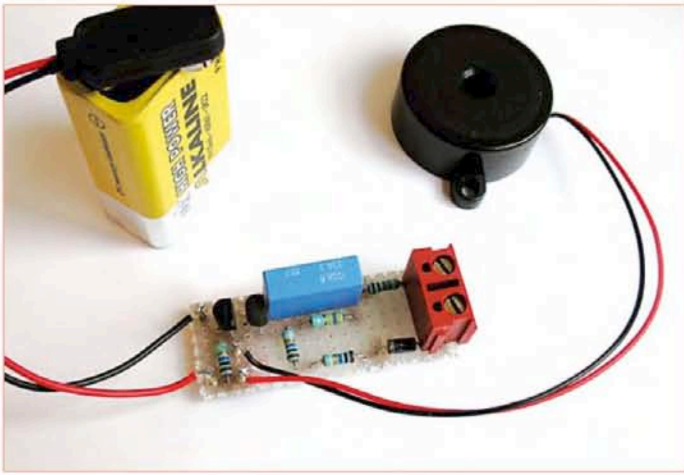
Power cut alert

Apart from the icecaps melting, the ozone layer vanishing and crazed meteors crashing into us, there's still one thing you can rely on, at least in most countries: the national power grid. Or can you? Even in these days of technology, power cuts happen more often than most people realise. Depending on when you get round to figuring out what's wrong, the consequences usually vary from finally getting a good night's rest due to your alarm clock failing, to finding your prize turkey defrosted and dripping goo in the freezer. If you don't like a good night's rest or if you really like turkey, this circuit might be something for you.

Whatever the case, you'll always discover the truth too late (a statement which can be inferred from Murphy's Law). To prevent problems from occurring due to a power cut, this power cut alert has been made. The circuit continually keeps an eye on the AC grid voltage and gives an acoustic alert when it drops below 50 V or so for more than a second roughly.

The circuit is very simple. In fact, it actually isn't more than a potential divider connected to a buzzer. The divider, which consists of the resistors R1, R2, R3 and R4, reduces the voltage from the AC grid to a voltage which can be handled by the rest of the electronics. The circuit is designed for 230 VAC, so readers on 110-120 V grids have to redimension the components accordingly. Diode D1 rectifies half of the alternating current so the circuit is fed with a 'kind-of' DC signal (pulsing).



Under normal circumstances, the voltage across R3 is high enough to keep T1 in conductance. The gate of T2 receives a too small voltage to keep this MOSFET conducting so no current from the battery can flow through the buzzer, resulting in silence.
As soon as the national (or state) AC grid voltage drops below 50 V, the voltage across R3 drops below the threshold needed to keep T1 in conductance. When this happens, the voltage at T2's gate becomes high enough (through R5) to start conducting. Now a current can flow through the buzzer by way of T2, causing a loud tone, indicating that a power cut has occurred.

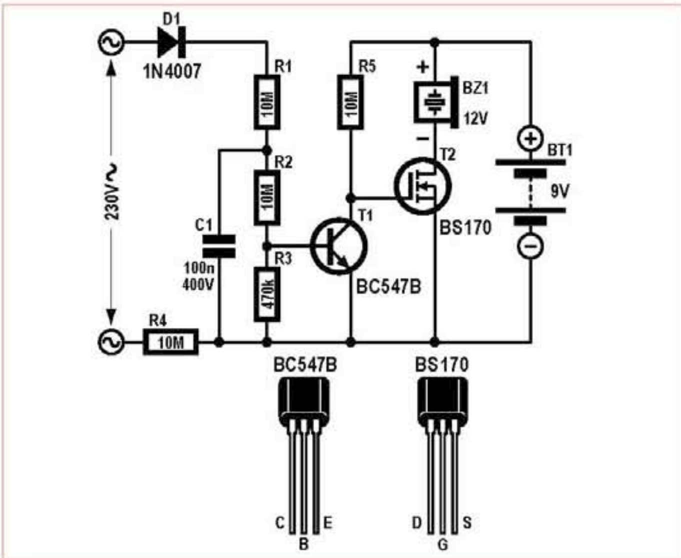
The details

We chose a value of 10 MΩ for the resistors of the potential divider (R1, R2 and R4) because these are widely available. Make sure you get resistors which can be used at voltages of at least 350 V! With a total resistance of 30 MΩ, the maximum current passing through these resistors is roughly 10µA, which is negligible. The value for R3 is 470 kΩ so the circuit kicks in when the AC grid voltage drops below 50 V. Because the power coming from the grid is alternating current (AC), the voltage drops below the threshold 50 times (or 60 times) a second. We don't want the circuit to respond to these perfectly normal dips, so that's why C1 was added. This capacitor causes the circuit to react if the voltage has been low for longer than a second only. Keep in mind though, that this capacitor is also directly connected to the AC grid. Therefore, it must be capable of handling voltages of at least 400 V. T1 is a standard NPN transistor. For T2 we chose a MOSFET to allow R5 to have a high resistance (10 MΩ). The current which runs through the circuit in normal circumstances (when T1 conducts) is just 1 µA, allowing the battery to stay good for years. It's best to use a normal battery instead of a rechargeable one, since rechargeables are subject to much greater self discharging. If a normal BC547 would have been used for T2, the resistance of R5 would have needed to be lowered to about 47 kΩ, causing the required current to increase by 0.2 mA!
The buzzer in our prototype is a CEP-2260A, which draws just 5 mA at 9 V. If we assume a battery capacity of 500 mAh, the circuit can buzz for four whole days. 12 V buzzers which draw 50 mA are also available, but the use of them is discouraged.

The construction

The circuit can be built on a piece of prototyping board of just a few square centimetres, but keep in mind that the whole circuit is at AC grid potential. Mistakes in the assembly could have life threatening consequences!

At the very least, the circuit needs to be made safe to touch, by encasing it in a proper ABS housing. Furthermore, the AC power line connector may NOT be directly soldered to the circuit board. It needs to be connected through a terminal block, with a distance of at least 5 mm (0.2 inch) between the terminals. All the copper pads need to be removed around all pads which are connected to the AC grid voltage (and around the resistors R1 and R4) to ensure an uninterrupted electrical isolation distance of at least 3 mm (see the picture of bottom



of the prototyping board). Here we should repeat that it is critical to use resistors which can handle voltages up to 350 V for R1 through R4, and a 400-V rated capacitor for position C1.
The power cut alert can be tested after construction by plugging it into the AC power outlet, and then by pulling the plug again. The buzzer should produce a loud noise.

Remember: Never change the battery while the circuit is still connected to the AC power line!

All now all that's left is a good night's rest, and a tasty turkey!

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