Poltergeist

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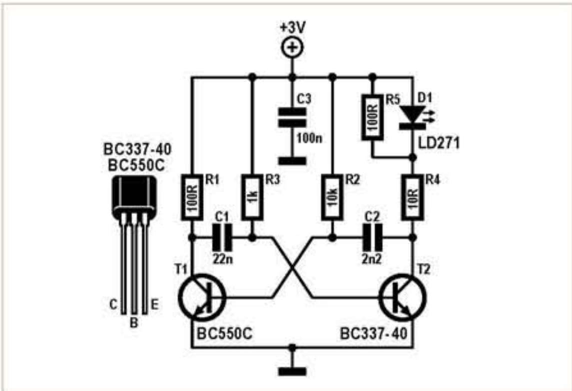
Sometimes, and luckily on the rarest of occasions, our in-house designers suddenly stop being serious and start mucking around a bit. The result, which always ends up on editors' desks, is usually pretty neat, most of the time plain weird, hardly ever useful or even practical, but invariably fun to build. This Poltergeist is one of those projects. It's the perfect circuit to give your roommates the payback they so justly deserve.

The vast majority of modern remote controls for televisions employ an infrared signal (the versions which work with ultrasound have all but disappeared). The remote control normally contains an oscillator which produces a square wave (the carrier signal) with a frequency between 33 and 40 kHz. One commonly used standard is called RC5; this uses a 36 kHz carrier signal. Information is carried by switching this signal on and off in a predefined manner. This method of modulating information is called AM (Amplitude Modulation) and uses a 'modulation depth' of 100%. The resulting signal is used to pulse an infrared LED, which radiates the signal through space right up to the TV set. The television set contains an infrared detector which reacts to carrier signal so the information can be received and recovered.

So, what if you create a circuit which constantly sends a signal with a frequency of 36 kHz, and point it in the direction of the IR detector on the front of the television set? Since the television is constantly receiving a signal, any signal sent by a real remote control will be jammed so it won't show up! The decoder in the television won't be able to differentiate between the two signals, causing it to stop reacting to the commands sent by the remote control. This is our Poltergeist's evil master plan.

The circuit is quite simple. Transistors T1 and T2 are part of a regular astable multivibrator. Its workings aren't that hard to understand. If T1 is in its conducting state, the voltage on the collector drops to 0 V. This change in voltage is passed through C1 to the base of T2, causing this transistor to stop conducting. In this state, current



flows to C1 through R3, eventually allowing the voltage across the capacitor to rise high enough to open up T2 again. This, in turn, causes the right side of C2 to be pulled down by T2, which causes T1 to block all current, allowing C2 to be charged by R2 until T1 starts conducting again, leaving the cycle right where it started. This goes on for all eternity. Well, at least until the battery dies...

We chose a standard transistor, type BC550, for T1. T2 is a slightly more powerful device type BC337, which can handle currents up to 500 mA (or 1 A for short periods of time) allowing it to switch the relatively high current (150 mA at 3 V) through the infrared LED D1.

The frequency of this simple oscillator can be calculated using the R-C time. If R2×C2 equals R3×C1, the time the transistor conducts theoretically equals R×C×ln2, where ln2 is the natural logarithm of 2.

A low battery voltage and the voltages at which the transistors switch can mess things up a little. This causes the frequency to vary with a changing voltage. The threshold voltage of D1 also exerts some effect, though this is more or less compensated by R5, which sits in parallel with D1 and improves the charging of C2.

The following table gives an impression of the change in frequency in our prototype:

	31.8
4	33.6

The required current is highly dependant on the supplied voltage, as can be seen in this table:

Power source voltage U (V)	Current I (mA)
0.8	7
1	10
1.5	23
2	47
3	97
4	147

When the voltage drops below 0.8 V, the oscillator becomes unstable. We also recommend not using a voltage higher than 4 V. Two AA batteries are ideal, although a small wallwart (AC power adapter with DC output) could also be used.

A circuit like this is very open to experimentation. By changing the value of C2 to 1.5 nF, the frequency becomes exactly 36 kHz, when using a power source of 2.5 V. Furthermore, if C1 is changed to 18nF, the frequency becomes 40 kHz between 3 V and 4 V, which is exactly the frequency Sony uses in their remote controls. The current consumption can be limited by changing the ratio of the two capacitor values. If the ratio of C1 and C2 is increased, the pulse through D1 becomes shorter. In other words, the duty cycle is shortened.

We tested this circuit in the lab at a frequency of 40 kHz. The Poltergeist was placed at a distance of 3 m (10 ft.) from the television set. The remote control didn't show any sign of control when used at a distance greater than about two metres (7 ft.).

This Poltergeist can be improved by using a higher voltage than 3 V, or by replacing the LD217 (D1) by an LD274. The latter creates a more focussed bundle of light, creating a more intense beam. The Poltergeist will need to be directed more accurately though.

The construction of the circuit is pretty much self evident. The whole circuit can be built in half an hour on a piece of prototyping board, as is shown in the picture. Oh, and remember: a little teasing is fun, but don't take it too far!

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