The Infinity Bug

This is an amazing project . . .

us**$55.00** plus $6.50 post

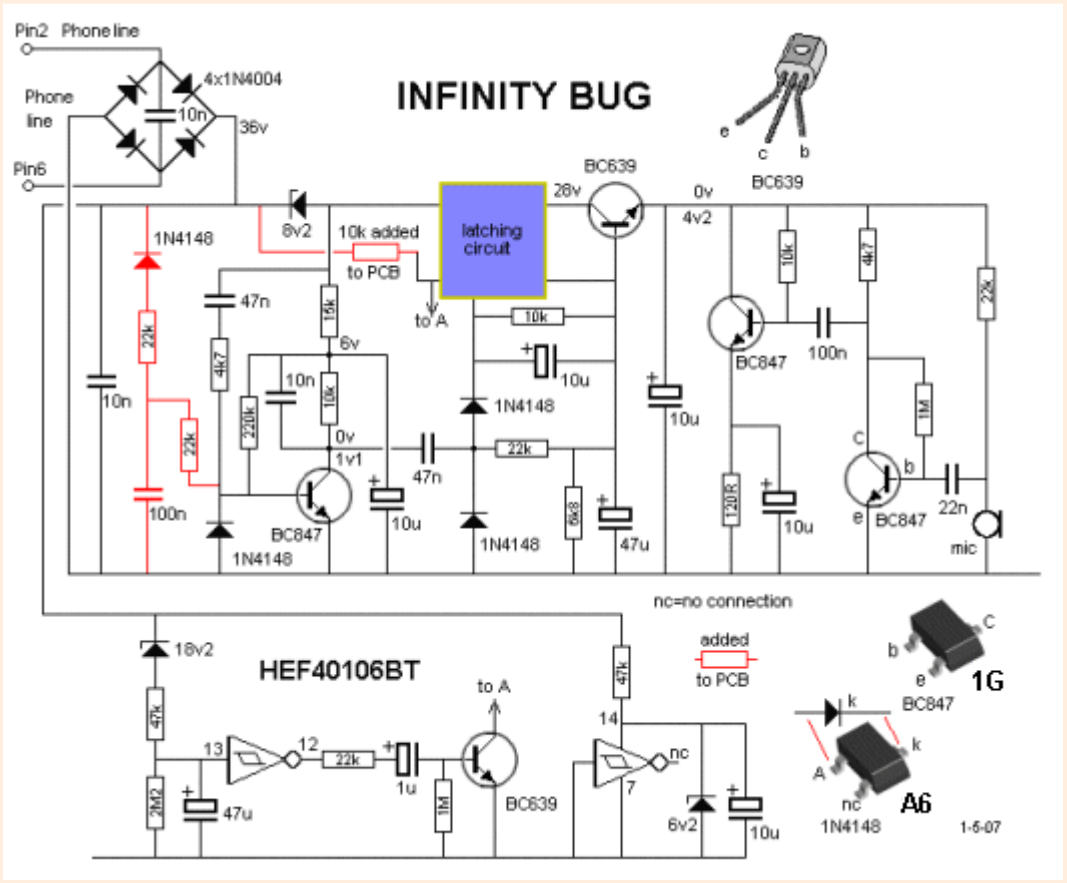
Order kit

Fully assembled version $199

Order Infinity Bug

The INFINITY BUG is connected across the phone-line of a distant phone (in parallel mode).
To use the Bug, the distant phone is rung. After having a conversation with the person at the other end, they will replace the receiver.
At this point you whistle into the receiver and the Infinity Bug will pick up the line. The high-gain amplifier in the Infinity Bug will pick up the audio at the place where it is located.
It does not have to be next to the distant phone. It can be anywhere, provided it is connected across the phone line of the distant phone.
A timing circuit in the device will cancel after 3 minutes. To open the Bug you need to whistle again. This can be repeated any number of times.
If the phone is picked up, it cancels the Bug.

This project requires a high degree of soldering. It uses surface-mount resistors, capacitors transistors and diodes.
It can **only** be assembled on the PC board supplied in the kit as the Latching Circuit is already soldered to the board and the project will not work with substitute components.



Infinity Bug Schematic

Click schematic above for larger version.

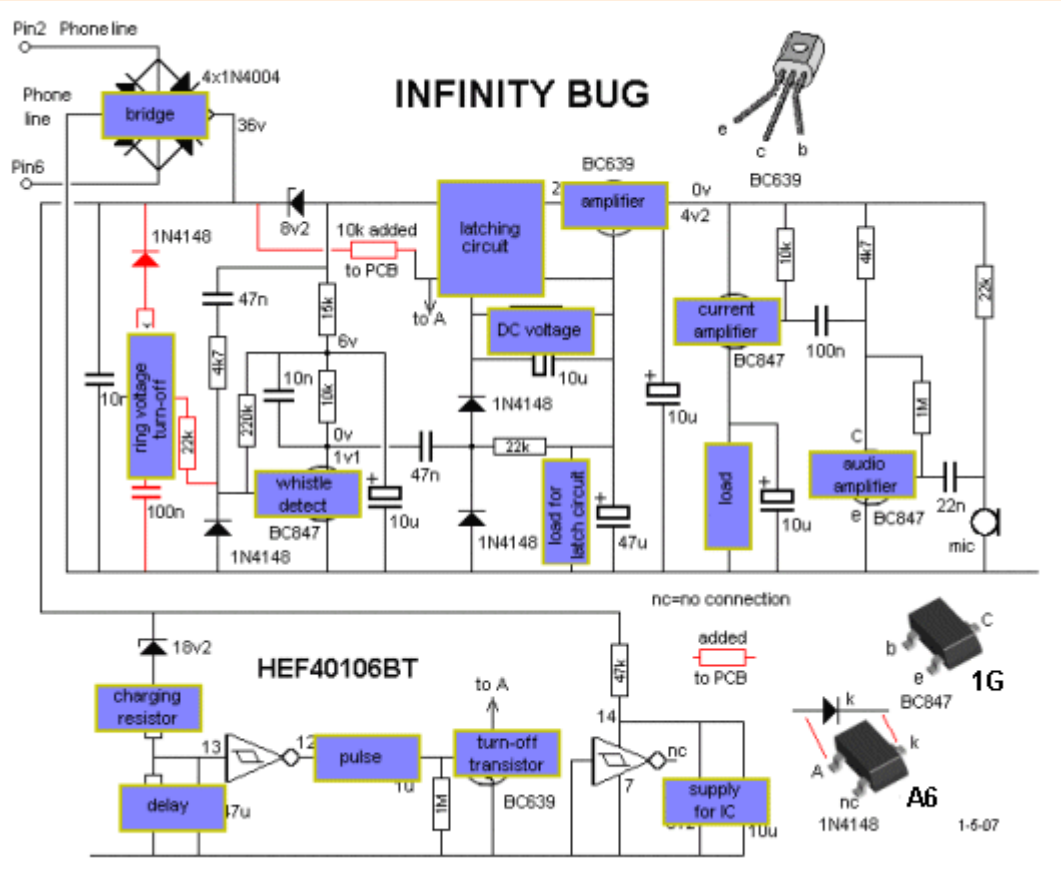
(move your mouse off the screen and back again to get the enlargement arrows for large schematic)

or click HERE to download schematic as .pdf

HOW THE CIRCUIT WORKS

The Infinity Bug consists of a number of blocks, plus components that perform very important tasks.

The following diagram shows the function of each of the components:



The Infinity Bug connects across the phone line and takes very little current as most of the circuit is not active when in the "waiting" state.
This is called "leeching" and the Infinity Bug is a leech device as it gets its operating current from the phone line.
Some phone systems detect as little as 0.5mA and if more than 1mA is drawn from the line, it remains engaged.
The voltage of a phone line varies from 42v to 55v, depending on the service-provider and the Infinity Bug will operate on this voltage range.
When the Infinity Bug is connected to the line, the "line voltage" will drop to about 36v, due to the current drawn by the bug. This will not upset the operation of the phone system.

The bridge on the front-end allows the project to be connected either way around and allows for the annoying feature of some phone lines. They create a voltage reversal as soon as the phone is picked up and this would defeat a Bug that requires a polarized voltage.
The only two sections drawing current during quiescent conditions is the whistle-detecting circuit made up of the BC 547 and its surrounding components. This section draws less than 0.25mA. It is frequency sensitive and will not detect the 33Hz ring frequency. The other section is the "timing section," made up of the 40106 IC. This is a hex Schmitt trigger (the same as 74C14).

Another feature of feature of the circuit is the 8v2 zener.
When a phone (that is connected to the same line as the Infinity bug) is picked up, the line voltage drops to about 12v and the whistle-detecting circuit does not see any voltage, as the 8v2 zener drops nearly all the available voltage.
Thus the circuit has a self-cancelling feature.
The principle of operation of the bug has been described above and when the handset is put back on the phone, the line voltage rises.
This allows the person at the other end of the line to whistle.
The tone produced by the whistle is passed through the 47n and 4k7 to the base of the BC 547 transistor.
The transistor amplifies the signal to produce a 2v p-p signal that is turned into a DC voltage by the 10u. This turns on the latch circuit and the base of the BC 639 is raised to produce a voltage on the emitter of about 4.5v
The actual voltage on the emitter of the BC 639 is determined by the 120R in the emitter leg of a BC 547. The BC 547 is almost fully turned on by the 10k resistor between the collector and base.

The 47u on the base of the BC 639 holds the base rigid to any AC signals so that the transistor operates as an emitter follower.
The transistor acts as an impedance-matching stage as the phone-line has a relatively low impedance while the pre-amplifier section has a quite-high impedance.
Finally, the microphone is connected to microphone pre-amplifier stage consisting of a BC 547 transistor, 1M bias resistor, 4k7 load and 22n input capacitor.
Thus the audio section consists of 3 stages in a very unusual arrangement.
This is necessary as the signal has to be delivered to the same line as supply voltage.

The Infinity Bug turns off after about 3 minutes due to a timing circuit connected to one gate of a hex Schmitt trigger IC.
The voltage across the IC is set to 6v2 via a zener so the timing can be controlled as the lower threshold at which the chip will change state is determined by the supply voltage.
When the line voltage rises to 50v, the 47u in the timing circuit is rapidly charged via a 47k resistor that is connected to the rail via an 18v zener. This put a maximum of 6v2 on the 47u as the input of the chip cannot rise above the supply on the chip due to diodes on the input of the gate.
When the Infinity Bug is turned ON via a whistle, the line voltage falls to about 12v and the 47u in the timing circuit does not see any charging voltage as the 18v zener removes this voltage.
The 47u is now slowly discharged via a 2M2 and when the voltage falls to below 2v, the output of the gate goes HIGH. This HIGH is passed to the base of a BC 639 via a 22k and 1u electrolytic.
The transistor removes voltage from the latching circuit and the Bug drops off the line. The 1u allows a pulse to activate the "turn-off" transistor.
The 1M on the base discharges the 1u so that it is uncharged in readiness for the circuit timing out.

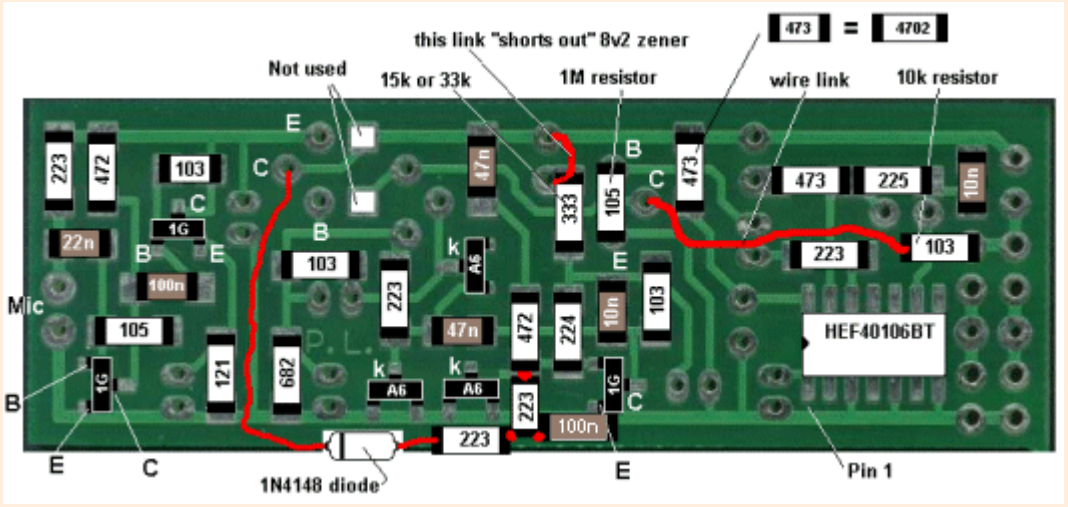
The 1N4148 signal diode connected to the rail of the project is connected to a 22k and 100n. This arrangement detects the "ring voltage" (approx 150v) and the zener of the signal diode allows the 100n to charge via the 22k. All diodes have a maximum reverse voltage and the diode we have chosen has a voltage of about 110v. This voltage can be called it "zener voltage." Any voltage above this "zener voltage" will pass through the diode. We have used this feature to keep the whistle-detect transistor turned on during the time when the phone is "ringing."

There are a number of other features of the circuit contained within the Latching Circuit that allows the project to operate successfully, but these have been kept secret and are mounted on the PC board when a kit is purchased.

CONSTRUCTION

Before any construction is undertaken, you must be familiar with surface-mount technology. We have a number of simple projects to allow you to get practical experience with these devices. See our Phone Ring project, for example.
Once you have soldered these components you will understand the difficulty in handling and soldering them to the board.

The surface-mount components are generally the first to be soldered to the board. But in this project, there are through-hole components and surface-mount components. If you add the surface-mount components first, make sure you do not "fill-in" any of the holes for the through-hole components. One component, a 1M (105) is mounted on the same lands as the base-emitter leads of a BC639 transistor.
The printing on the surface-mount chip indicates pin 1 at the bottom-left as shown in the diagram. This is one of the few times when the printing on a device indicates pin 1.
The case of the electret microphone goes to the "-" on the board. This is the negative rail and runs along the bottom of the board.



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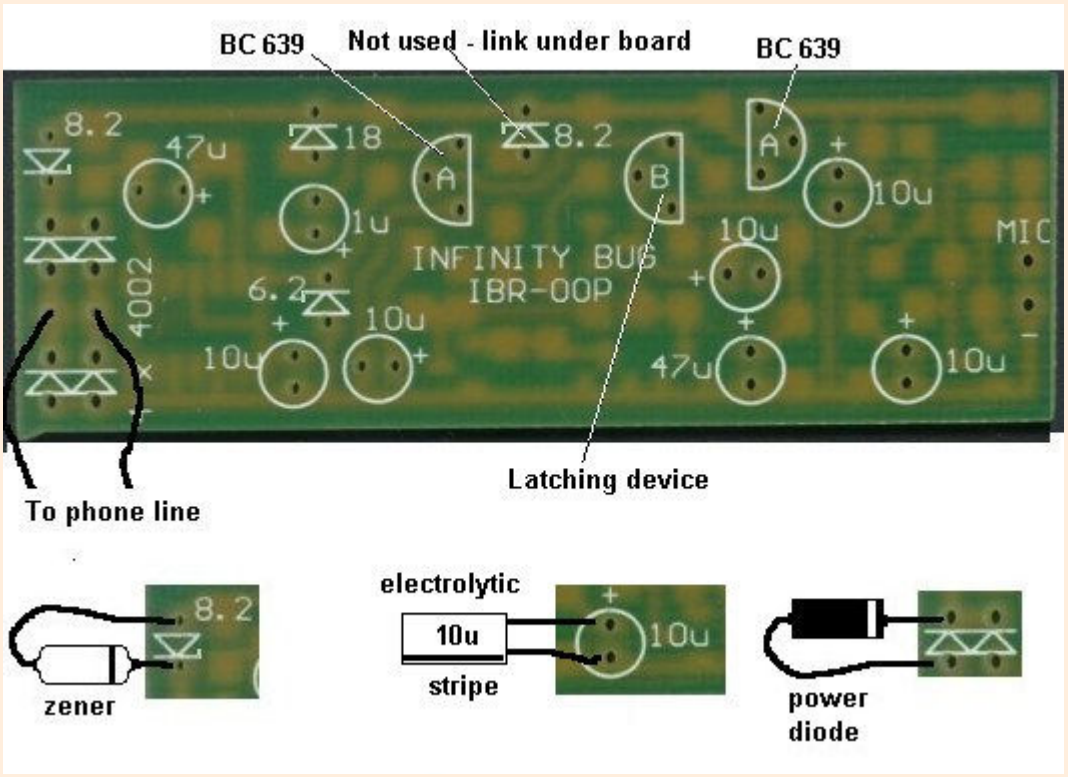
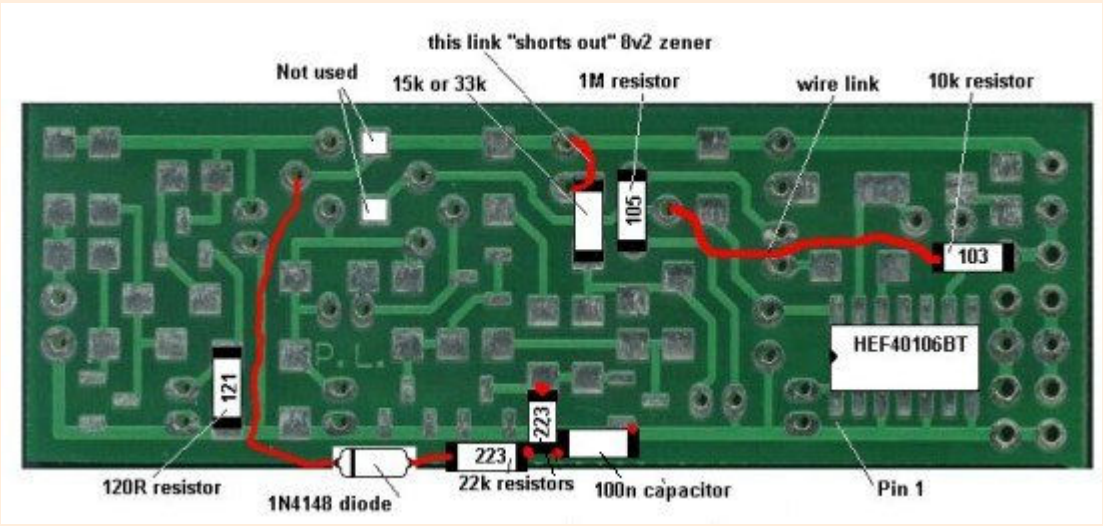


Topside of Infinity Bug

The diagram below shows the modifications to the underside of the board as well as some of the surface-mount components in their correct positions as per the circuit diagram.



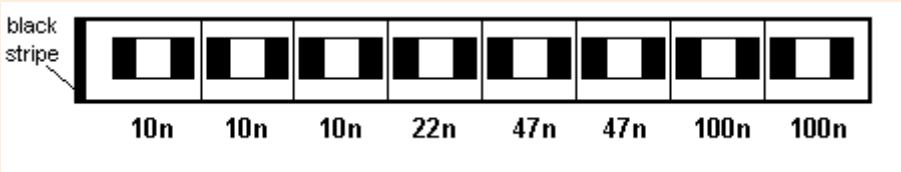
Refer to the placement diagram for the position of each component.
The resistors are identified by either 3 digits or 4 digits.

Click for the complete range of SM resistor markings for 3-digit code:

Click for the complete range of SM resistor markings for 4-digit code:

Solder one end by firstly adding a little solder to one land and placing the resistor in place. Hold the resistor in place with fine tweezers or an opened-out paper clip and bring the iron to the end of the resistor to re-melt the solder. The resistor will sit down onto the board. You can now solder the other end.

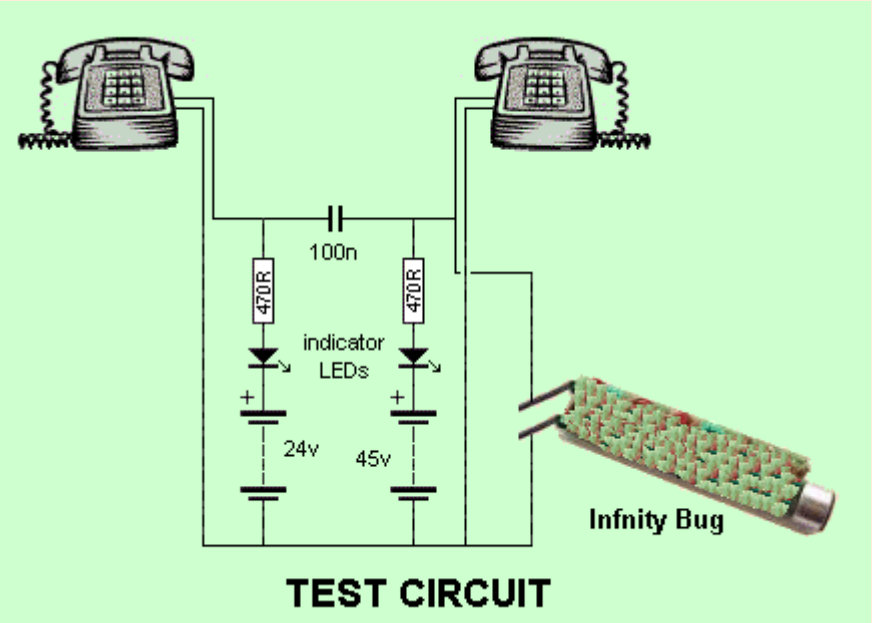
The surface-mount capacitors are not identified and are contained in a strip for this project in the following order:



Do not remove any of the capacitors until they are required.
Only remove one at a time and solder it to the board. The size of a capacitor is not an indication of its values as some are multi-layer.
The transistors and diodes are contained in the same package.
The transistors are marked "1K" or "1G" and the diodes are marked "A6."
They are temperature sensitive and are more difficult to solder than the resistors as they are smaller and must be soldered quickly.
Once all the surface-mount components are fitted, the through-hole components are added.
All the through-hole components are polarity sensitive and must be fitted around the correct way.
The final things to add are the electret microphone and the two leads with alligator clips.

TESTING THE INFINITY BUG

To fully test the Infinity Bug you will need two phone lines. This is not often available and the next best solution is to build a "Test Rig."
The 470R resistors are current-limit resistors and the LEDs indicate when the phone and Infinity Bug are on the line.
The Infinity Bug can be tested with the following Test Circuit:



Connect the Bug to the test circuit shown above and pick up the left-hand phone.
Whistle into the mouthpiece and the Bug will pick up the line and you will be able to hear the ticking of a clock in the room.
Pick up the second phone and the Bug will drop off the line.
Replace the second phone and whistle.
The Bug will pick up the line again.
Keep listening to the Bug and it will drop off after about 2-3 minutes.
Whistle again and the Bug will pick up the line.
Repeat this again and if everything woks perfectly, the Bug is fully tested.

IF IT DOESN'T WORK

The first thing to do is measure the current taken by the Bug when it is connected to the line.
It should be less than 0.5mA and only the whistle-detecting stage should be active.
You will need a CRO to measure the amplitude of the signal produced by the whistle-detecting stage at the collector of the transistor. It should be about 2.5v p-p.
The DC voltage across the 10u electrolytic that provides a turn-on voltage for the latching circuit will rise to 0.6v and the bug will turn on.
When the bug is turned on, the emitter voltage on the BC 639 will be about 4.5v. This voltage is created by the value of the 120R resistor as it is the load resistor for the project.
The 4.5v becomes the rail voltage for the audio stages and the only way to test the audio stages is with a CRO.
Since the Bug is connected to a current-limited power supply (the 470R in the test power supply provides current limiting) you can use a jumper on the project with fear of damaging anything.
To test the audio stages, connect a jumper between point "A" on the board and the base of the BC 639 amplifier transistor. You will be able to hear the faintest sounds in a room.
If audio is not detected, measure the voltage on the collector of the first audio transistor. It should be about 2v.
The second transistor should have about 4.5v on the collector and 4v on the emitter.
The most common fault will be a faulty connection to one of the surface-mount components or a damaged transistor.
You will need a CRO to detect the passage of audio through each of the stages.

There are a number of critical components in the circuit and the audio section is very important.
The current taken by the audio section causes the rail voltage to drop to about 4v2 when the bug is active. This voltage is determined, mainly by the 120R resistor in the emitter of the second stage. The transistor is turned on by the 10k resistor between the base and collector and the transistor is actually a common-emitter device, although it appears to be an emitter-follower.
If the 120R is increased, the voltage on the section rises and creates a feedback squeal.
If the 22k load for the microphone is decreased, a squeal is also created.
If the microphone is removed, a squeal is also created.

Everything is complex as we are creating an audio signal on the same lines that are supplying the voltage to the circuit.

A fault-finding service available from Colin Mitchell by clicking HERE.

Infinity Bug

PARTS LIST

au**$65.00** plus $4.50 post
us**$55.00** plus $6.50 post
Order kit

1 - 120R all surface mount
2 - 4k7
1 - 6k8
4 - 10k
1 - 15k
5 - 22k
2 - 47k
1 - 220k
2 - 1M
1 - 2M2

3 - 10n surface-mount capacitor
1 - 22n surface-mount capacitor
2 - 47n surface-mount capacitor
2 - 100n surface-mount capacitor
1 - 1u 16vw electrolytic
5 - 10u
2 - 47u
4 - 1N 4004 power diodes
3 - BAS surface mount diodes "A6"
1 - 1N4148 signal diode
1 - 6v2 zener diode
1 - 8v2 zener
1 - 18v zener
3 - BC 848 surface-mount transistors 1K or 1G
2 - BC 639 transistors
1 - HEF40106BT surface mount IC
Latching components
1 - electret microphone insert
2 - black alligator clips
30cm black hook-up flex
5cm very fine tinned copper wire
5cm - fine enamelled wire
1m - very fine solder
1 - Infinity Bug PC board

Kits for **Infinity Bug** can be obtained from Talking Electronics:
http://www.talkingelectronics.com

Xc 21/06/07 with corrected 100n and 22k's