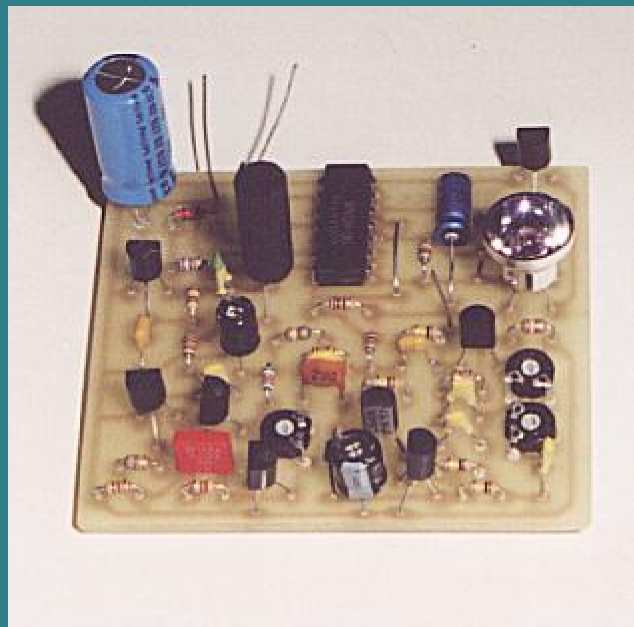
Inline graphics on this page: 35K

Infrared `Radar'

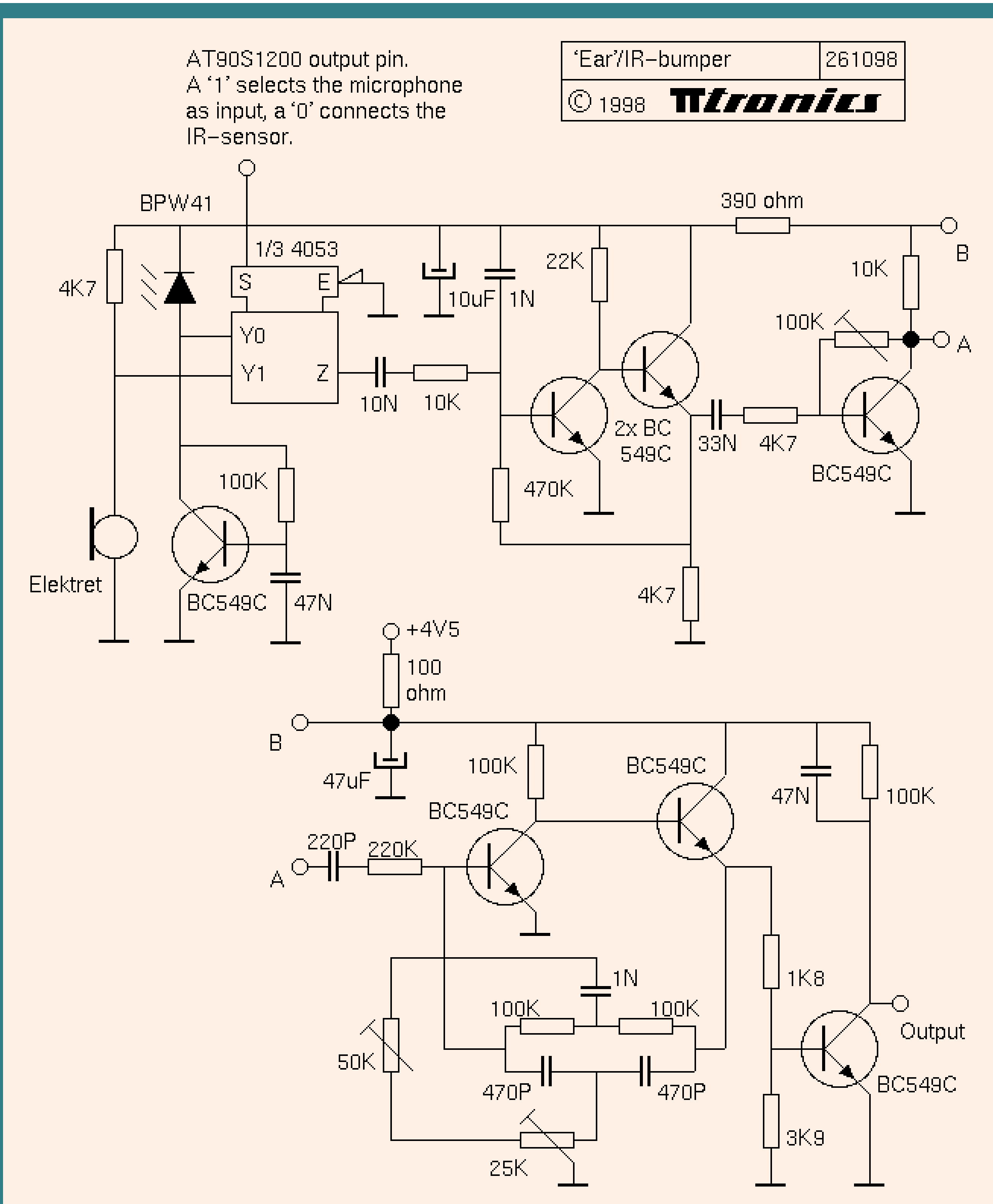


Transmitter and receiver combined on a single board, not including the microphone and 4053 multiplexer; this is a prototype of just the IR part. The 4053 switching was tested later and had no discernable effect on either IR or sound performance. The black bit high on the left is a photo diode (an SFH203FA instead of the recommended BPW41), equipped with a black paper tube. A little plastic reflector bundles the light emitted by the SFH484 on the right.

As currently planned, the Spider's ears share their inputs to the `brain' with two frontal feelers. Quite reasonable, since the Spider has to stop in order to listen, or else his own noise might block reception of weak chirps. odinary feelers are of course rather low-tech. An obstacle has to be touched before avoiding action can be taken. It is more interesting if the Spider actually sees table legs, walls and other objects in its path, and changes course before contact is made.

The easiest way to achieve this is a kind of infrared `radar'. One or more infrared LEDs are used to transmit short bursts of modulated infrared light. Photo diodes pick up any light reflected by obstacles. Thanks to the modulation, the receiver(s) connected to the photo diodes are able to separate the reflections from ambient light, be it natural (constant) or artificial (modulated by the AC mains). Since 4.5 KHz is a quite acceptable modulation frequency, the ears can double as infrared receivers, if the Spider is able to switch from microphone to photo diode and back at will.

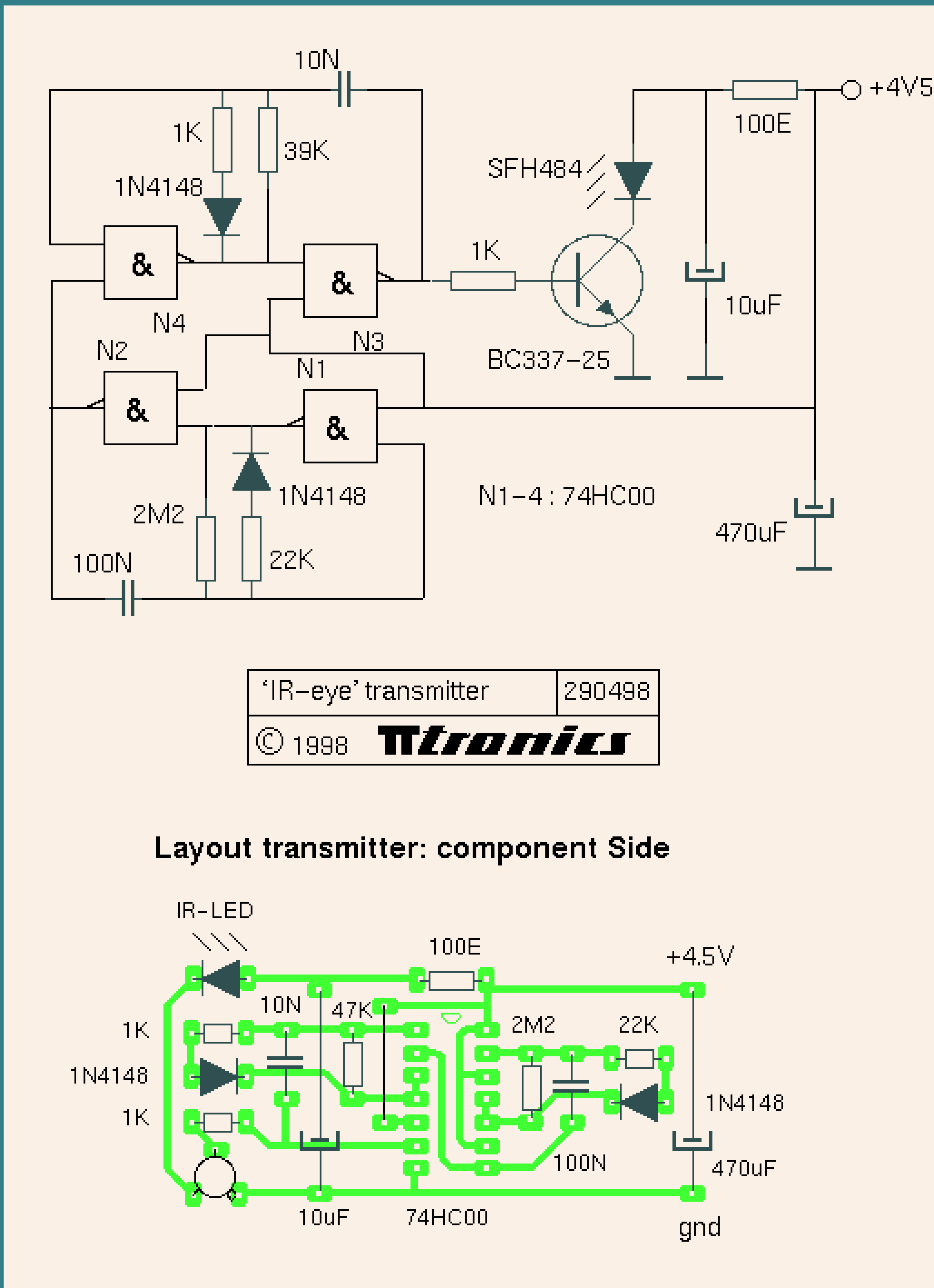
Receiver



For clarity, a complete pre-amplifier and filter combination is drawn, representing one of two channels (left or right). One third of a 4053 analog multiplexer switches between infrared and sound. The select inputs of both channels are connected to a single output pin of an AT90S1200 (the Spider's `brain').
The bias circuit between the anode of the BPW41 and ground makes the photo diode nicely receive the weak infrared reflections even when a fairly strong light source is shining directly into its face. Still, it is best to give it a black paper `hood' so it can see only straight ahead. That may well be needed anyway, to make sure it doesn't see any direct light coming from the transmitter. For the

same reason it is wise to put the transmitting LED not too close to the receiving BPW41. They should be aimed in the same direction, though; thanks to the reflector, the system is quite directional, which should help in smartly plotting a course between the legs of tables and chairs.

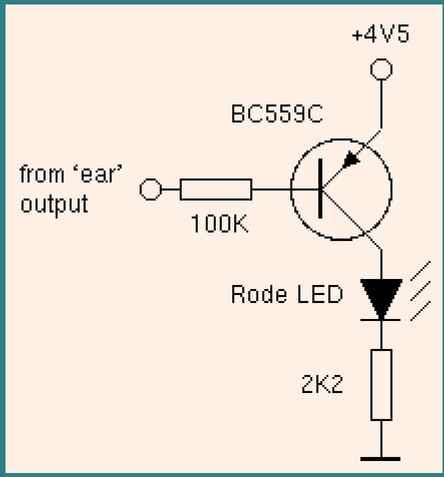
Transmitter



Because output pins on the Spider's `brain' (AT90S1200 uC) are scarce, and its thinking powers are used for higher purposes than simple pulse timing, a few 74HC gates are used to provide the short bursts of infrared. The duty cycle is very asymmetric to acieve best power efficiency. For each 2.5 ms burst there is a 200 ms pauze, and each burst consists of about ten cycles of 30 us on time and 200 us off time. So the LED is on for only 0.2 % of the time.
This results in a total power consumption (transmitter and receiver together) of 1.2 mA at 4 V. With

that tiny amount of power, the system `sees' my hand at 50 cm from the sensors. A light colored wooden stick (18 mm diameter) is seen at 40 cm, a white wall at 70 cm and a matt black surface at about 20 cm.
The circuit was tested with an SFH484; any good 5mm infrared LED should do fine. It was equipped with a little plastic reflector.

Adjustment of just an IR `radar'



If you want just the IR `radar', then don't include the microphone, its bias resistor and the 4053. In that case the pre-amp and filter may be adjusted for best IR performance. Connect the little test circuit on the right to the filter output. Power up transmitter, receiver and test circuit.

Start by reflecting the transmitted light to the receiver with a mirror. Center all three potentiometers. Turn the 50K pot (adjusting the sharpness of the filter) until the LED lights continuously (filter too sharp and oscillating). Turn it back about 20 degrees.
Turn the 25K pot slowly (frequency adjustment), looking for the point where the LED blinks in a 5Hz rithm. This is likely to happen within a wide tuning range. Gradually turn back the 100K pot (to decrease pre-amplification). This will narrow the tuning range. Center the 25K pot within the range found, and increase the sharpness.
Use a white wall at some 30 cm distance to reflect the light and check the tuning. Then increase the distance to 60 cm and check the tuning again. Try to get response from the LED with as little pre-amplification as possible. Finally check that the filter is not prone to oscillation, reducing sharpness a little if necessary. Disconnect the test circuit.

If you use this circuit for a `bot of your own design, remember that a target in range is indicated by the output becoming briefly zero, five times a second. That signal must trigger your design's evasive action.

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