Cycle computer diagnostic tool

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What can you do when your bike computer goes on strike? That's exactly the problem the author of this design had while on a cycling tour; suddenly no speed indication. A change of battery didn't help. To find out if the fault was with the transmitter or the receiver unit he built this handy piece of test equipment.

Once you have explored all the usual suspects and the equipment still refuses to work there is nothing for it but to grasp the nettle and read the manual. In tiny print in the handbook that accompanied the cycle computer it stated that the frequency range of the signal between the transmitter unit near the wheel and the receiver in the computer on the handlebar was in the range of 120 and 122 kHz and the signal strength did not exceed -16 $dB_{\mu A}$/m measured at a distance of 3 m. These figures comply with existing regulations for such equipment so it is likely that they also apply to the majority of other makes of basic cycle computers.

Considerations

The information in the manual proved useful to start designing a diagnostic tool for the equipment. Frequencies around 120 kHz are at the lower end of the long wave band. The aim now was to build a transmitter and receiver operating at this frequency. Searching for a suitable solution I recalled an AM receiver chip type ZN414 made by Ferranti in the late 1970s. At the time it was very popular; being one of the first highly integrated receiver ICs for radio use and had a good spec. Its bandwidth extended down to 100 kHz. Bingo! Not so fast... sadly the device is no longer produced but the

TA7642 made by Philips is a good substitute. Looking at its data sheet, it seems to have a very similar specification. This chip is also de-listed but there are many still stocked by various suppliers and they are also available from online auction sites.
The original goal was to build a receiver test circuit to pick up signals generated by the wheel rotation sensor. To start off with the TA7642 IC was used in its standard configuration. Initial testing was a bit of a headache but the outcome was that chip's receiver sensitivity is influenced by the supply voltage. When the voltage at pin 3 is greater than a certain threshold the receiver can be easily overdriven. Using a preset pot it is easy to adjust this voltage and change the receiver sensitivity.
The most difficult part of the construction was going to be the antenna coil. The transmitter part of the bike computer is quite well encapsulated and difficult to dismantle without causing damage. I needed to find a quick and simple solution for the coil. Rummaging through a box of spare components I found some RFID coils still in their original packing. Result! The coils usually operate at a frequency of 125 kHz. They are generally operated in parallel with a 1 nF capacitor.

The test circuit

All the components were wired up using a prototyping plug board for simplicity and speed. The design for a two transistor amplifier circuit (T1 and T2 in **Figure 1**) is taken from a Philips application note for a headphone amplifier and adapted to drive the red LED. After the 3 V supply voltage has been connected it is necessary to adjust the operating point of the receiver IC. The voltage at pin 1 should be approximately 1 V. If the trimmer is adjusted so that the voltage on this pin is too high, the receiver will go into saturation and the LED comes on. For maximum sensitivity the trimmer is adjusted to a position just before the LED lights with no signal input. A piezo buzzer can be connected at K1 to make the received signal audible.
Once the receiver test circuit was up and running I tried to get the bike front wheel sensor to transmit by waving a magnet close to the sensor. There was no response at the receiver test circuit. I was fairly sure that the test receiver was working so now I needed to build a test transmitter circuit to generate the pulses to test the bike computer. I could get away with a simple oscillator circuit and an antenna coil here. It wasn't necessary to make too many calculations I could just use the same coil used in the receiver circuit. Resistor R7 and preset P2 form the emitter resistance for T3 and T4. P2 can be adjusted to allow some fine-tuning of the oscillator frequency.

Test & Diagnosis

It only took a few minutes to build the transmitter on a prototyping plug board and test it out. The complete circuit of the prototype can be seen in Figure 2. In use, push button

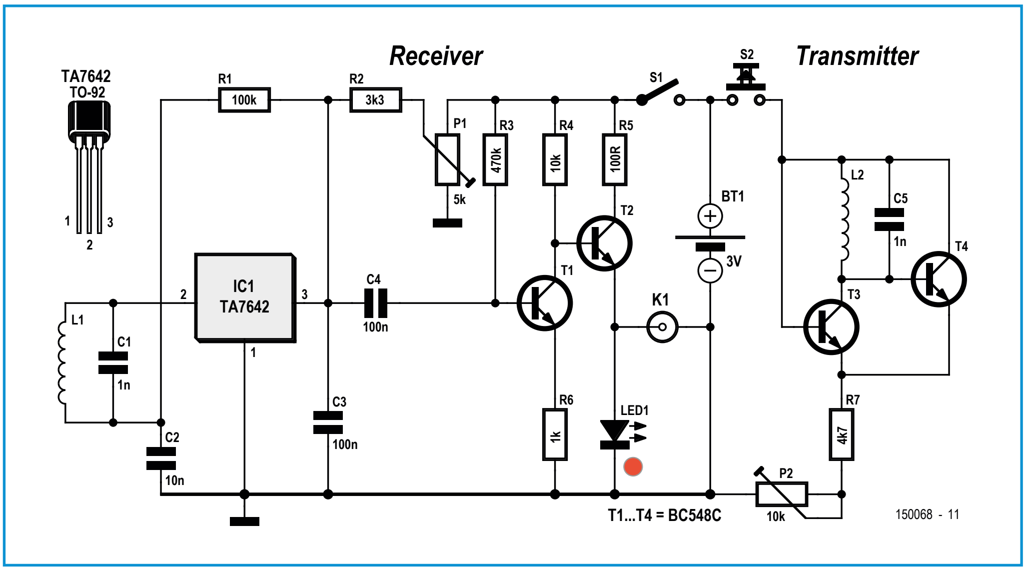

Figure 1.
The diagnostic tool circuit uses a transmitter and receiver.

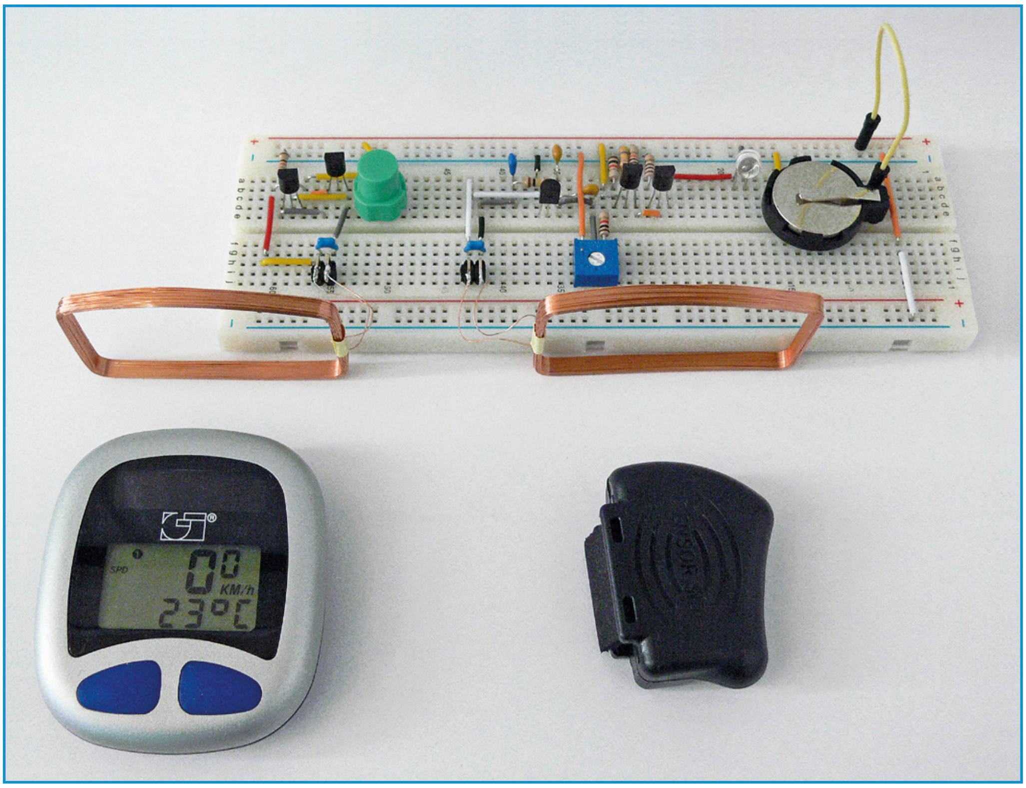

Figure 2.
Thanks to the highly integrated receiver chip the complete circuit fits on a prototyping plug board.

S2 can be pressed approximately once per second to simulate the speed of the cycle wheel revolving. The receiving part of the circuit now responded immediately and the red LED flashed in time with the push button action. The piezo buzzer also gave out a click at the same time. Now it was time to move the cycle computer close to the transmitter coil in the test equipment. At a distance of around 20 cm from the coil, the computer began to detect the signal and showed a speed reading corresponding to the rate at which the push button was pressed. That's a relief, the most expensive part of the cycle computer works correctly and the fault must be in the speed sensor and transmitter. The transmitter in the diagnostic tool has a resonant circuit that can be adjusted by trimmer P2. By connecting a frequency counter at the emitter of T3 it was possible to show that the cycle computer receiver had a relatively wide bandwidth; responding to signals in the range of 105 to 128 kHz.

All's well that ends well

There wasn't any doubt now; the fault was with the transmitter part of the cycle computer. Further investigation revealed that the magnet had no effect on the reed relay sensor and its contacts had in fact become fused together. It was replaced with a new one and once again the tester was used to check that everything worked correctly. Now when a magnet was passed across the transmitter coil the receiver LED lit up and the buzzer made a click. With the cycle computer refitted to the bike the display showed the correct speed reading. The diagnostic tool had proved its worth; tracking down the fault was a breeze. Finally it is important to note that this circuit is only suitable for the more basic type of bike computer. The more up to date high-end digital bike computers operate at a frequency of 433 MHz which is not supported by this design.

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