

Improved Infrared Tachometer Sensor

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Background

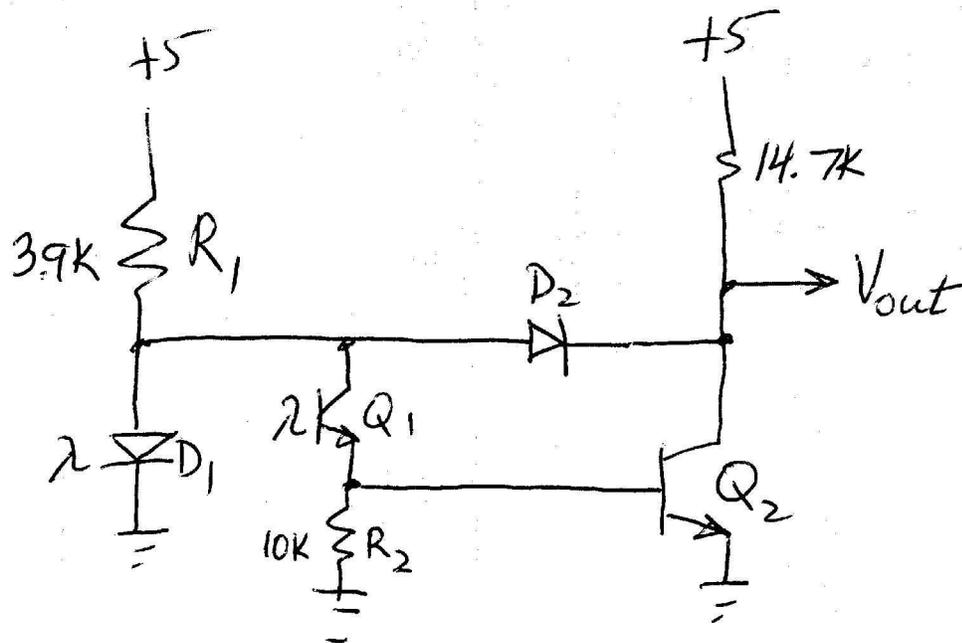
The existing Infrared Tachometer Sensor used for the DRO-350 and DRO-550 uses no feedback. The user must manually adjust the pull up resistor on the infrared phototransistor to achieve a usable logic 0 and 1. Once set, this arrangement seems to work well. A major problem occurs when the circuit is built by people not familiar with electronics. They must tinker with the circuit until it works and do not always get it working.

The improved circuit presented here uses 3 more parts and is self adjusting. The goal is to have a circuit that will just work after it is built.

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Circuit Description



D_1 is the Infrared LED and Q_1 is the Infrared phototransistor. They are arranged so that the light from D_1 reflects off of a rotating surface and into Q_1 . This surface is about 90% flat black and 10% reflective. As the surface spins, the light is reflected 10% of the time. When light is not reflected, the circuit outputs a logic 1. When light is reflected, you get a logic 0.

Parts list

D_1 L53F3BT photo diode; longer lead is the anode (positive)

Q_1 L51P3C phototransistor; longer lead is the collector (positive)

Q_2 2N4401

D_2 is any low power general purpose diode

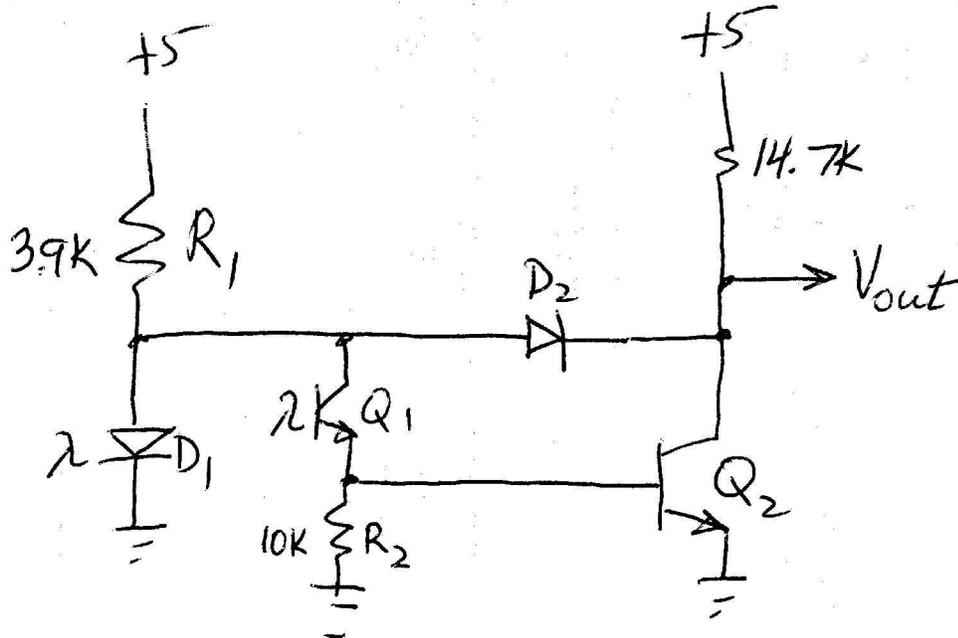
All resistors 1/8 watt or higher.

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Basic Operation

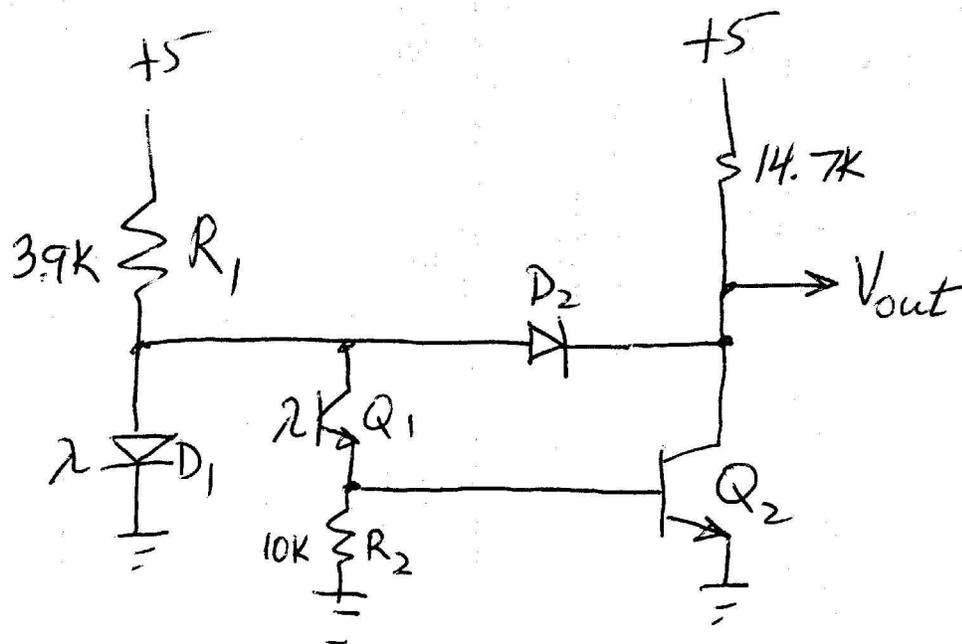
The voltage across D_1 is almost constant which means that the voltage across R_1 is essentially constant. The constant voltage across R_1 means that the current through



it is also essentially constant. This constant current is steered between D_1 and Q_1 as part of a feedback system. Q_2 assists Q_1 for added current gain. Given a drop across D_1 of 1.2V, the current through R_1 is about 1 mA.

State 0

In this state, the surface is flat black so the minimum amount of light reaches Q_1 . The current through Q_1 is therefore at a minimum and most of R_1 's current flows through D_1 giving it maximum brightness. It remains at this maximum brightness as long as the surface is flat black. The current through Q_1 is roughly 0.03 mA so the voltage across R_2 is roughly 0.3V. This is not enough to turn on Q_2 so V_{out} is pulled up to around 5V and D_2 is off.



State 1

In this state the surface is reflective so Q_1 starts to conduct. We now have a feedback mechanism involving the current through R_1 being split between D_1 and Q_1 . The more light that reaches Q_1 , the more current that flows in Q_1 . This increase in current through Q_1 causes a corresponding decrease in current through D_1 which causes it to dim. A balance is reached where D_1 is just bright enough to turn on Q_1 enough to be stable. If for some reason Q_1 sees more light, it will conduct more current which in turn robs D_1 of current. The lower current through D_1 causes it to dim which in turn will cause Q_1 to see less light. Balance is restored to the circuit.

As Q_1 starts to conduct, the voltage across R_2 starts to rise. When this voltage reaches about 0.6V, Q_2 starts to conduct. This causes V_{out} to drop and turns on D_2 . At this point there is more than enough gain to divert the full 1 mA of current from D_1 if necessary. Balance is achieved very close to an R_2 voltage drop of 0.6V and V_{out} sits at a voltage equal to the drop across D_1 minus the drop across D_2 or about 0.6V. For most applications, this is an acceptable logic low.