Bike Tail Light

Be seen even at standstill!

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As autumn approaches cyclists become more aware of safety and in particular their visibility to other road users. Dynamo lighting offers the cheapest running costs but has the disadvantage that when the wheels stop rolling the lights go out. This neat circuit stores energy while you are moving to keep the light shining even when you stop.

with Standlight

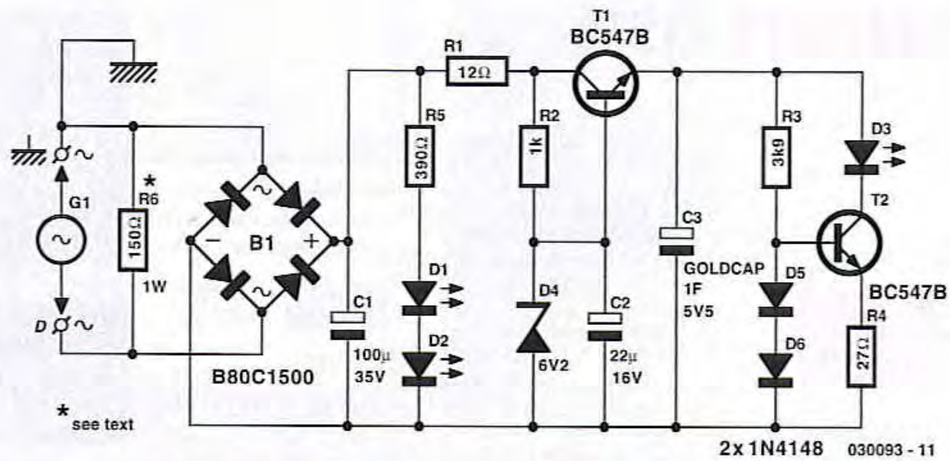

Figure 1. The circuit looks similar to a stabilised mains power supply.

It is not too difficult to construct a simple and reliable rear light unit for a cycle dynamo using high visibility LEDs. They have a much longer lifespan than filament lamps and this design uses a high value capacitor to store enough energy to keep the lamp burning for a few minutes after the cycle has come to a standstill.

The circuit

The circuit diagram for the rear light is shown in **Figure 1**. A typical cycle dynamo will only have a single output terminal; the return path is made through the dynamo body and cycle frame. A connection to the frame will form the earth input while the dynamo output is wired to the D input on the circuit. Rectifier B1 produces a full-wave rectified DC voltage and capacitor C1 provides some smoothing.

The Goldcap capacitor C3 is charged from the rectified dynamo output through resistor R1 and transistor T1. The zener diode D4 fixes the base of T1 at 6.2 V and its base-emitter drop of 0.7 V ensures that the voltage output at the emitter does not exceed the 5.5 V maximum voltage rating of C3. Capacitor C2 smoothes the voltage reference and resistor R1 limits the charging current through the transistor.

The constant voltage produced by T1 is used to charge C3 and also provide energy to light LED D3 when the bike is moving. D3 is an 8 mm diameter ultra bright red LED with a clear lens and a supply current of 26 mA. The 'F' suffix indicates that this model has a high luminous intensity in this range of LEDs manufactured by Kingbright (available from Maplin). The LED is driven by a constant current source formed by T2 and this ensures that its brightness is largely independent of the voltage stored on C3. Diodes D5 and D6 fix the base of T2 at approximately 1.4 V which in turn defines the voltage drop across R4 at 0.7 V because it is equal to 1.4 V minus the base-emitter conduction voltage of T2 ($V_{BE} \approx 0.7$ V). With the voltage across R4 fixed a quick application of Ohms law indicates that the current through R4 (and therefore D3) is constant at around 26 mA.

With the bike at standstill LED D3 is powered from energy stored in C3. Using the components specified D3 remains lit for at least two minutes before any decrease in brightness is noticeable. This afterglow period is defined by resistor R4, increasing its value to 33 Ω or 39 Ω will prolong the afterglow at the expense of reduced LED brightness. The light intensity of D3 is much higher than a conventional filament lamp but has a smaller beam angle. The two 'driving' LEDs D1 and D2 are powered directly from the dynamo output and are positioned either side of D3 to increase the effective beam angle of the rear light assembly when the cycle is moving.

Current consumption of the circuit is approximately 45 mA and with a dynamo output voltage of 6 V this gives a total power consumption of around 0.3 W. This figure is about one half of the power consumed by a conventional filament type rear lamp and reduces loading on the dynamo. The effect of this is that the voltage to the front lamp will be slightly increased

UK laws at a standstill?

In the UK lights on a bicycle are not required when stationary and to comply with the law the lamp should have a filament! British Standards have been updated to allow LED light sources and these have been commonly in use for a number of years but to be legal the lamp should have a filament. So a lamp with a BS approval could be illegal. The law is seldom if ever enforced on this point and rightly so because it's safety that matters. Cyclist also use flashing lights even though they are also technically illegal. Surveys indicate that most cyclists (about 90%) use battery powered lights.

The two documents concerning cycle lighting are the 1989 Road Vehicle Lighting Regulations and British Standard 6102 part 3. Any form of home-made lighting will not have BS approval. The Bike Tail Light described in this article should only be used as a secondary means of lighting which is fitted together with a BS approved system.

COMPONENTS LIST

Resistors:
R1 = 12Ω
R2 = 1kΩ
R3 = 3kΩ9
R4 = 27Ω
R5 = 390Ω
R6 = 150Ω 1W

Capacitors:
C1 = 100µF 35V radial
C2 = 22µF 16V radial
C3 = Goldcap 1F /5.5V (Conrad Electronics # 473120)

Semiconductors:
B1 = B80C1500, round case (80V iv, 1.5A)
D1,D2 = LED, red, 3mm, Kingbright L-934SRC-J (Reichelt, LED 3-3500RT)
D3 = LED super-red, 8 mm, Kingbright L-793SRC-F (Maplin # N46AT)
D4,D5 = 1N4148
D6 = zener diode 6.2V, 500mW
T1,T2 = BC547B

Miscellaneous:
Bike rear light case, Busch & Müller type 339, www.bumm.de/docu/ruecklicht1.htm (UK distributor: Amba Marketing)
PCB, available from the PCBShop

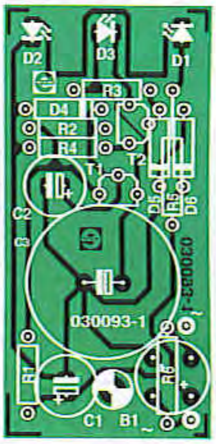

Figure 2. The small PCB is designed to fit into a standard rear light assembly.

and it will burn brighter for a given speed. This will reduce the front lamp lifespan if you habitually descend long hills at high speed. Resistor R6 is fitted as a 'dummy load' to avoid this potential problem but if you never break into a sweat while pedalling and your cycle is the type fitted with wicker baskets, you are unlikely to need this precaution and R6 may be omitted.

Construction

The circuit can be built on the single-sided circuit board. The PCB layout accepts conventional wire-ended components with some of them fitted to the underside (alternatively you can keep them all on the same side by fitting R5 over the top of D5/D6 and R6 under rectifier B1).

The PCB is quite small but this should not pose any problems when mounting the components. It is important to double check that all polarised components (diodes, transistors and electrolytic capacitors) are fitted the correct way round before power is applied to the circuit.

A 9 V battery or mains unit can be used to test the unit. The power source is connected in place of the dynamo, polarity is not important because the bridge rectifier ensures that power will always be correctly supplied to the circuit. At power-up all the LEDs should light and after a short charging time the voltage across the Goldcap can be measured (approximately 5.5 V) while the voltage drop across R4 should be less than 0.75 V.

Once the circuit has been tested, mask off the LEDs with tape and give the whole unit a few coats of spray lacquer to protect it from the effects of the weather. Once the lacquer is dry the unit can be mounted in the taillight housing. The PCB is dimensioned to fit in a housing type 339 made by the company Busche & Müller and distributed on the UK by Amba Marketing. It can also be adapted to fit into any similar rear light housing.

For the housing specified, the PCB is fitted behind the reflector part and fixed with a small (rust proof) self-tapping screw. Cycles are subject to surprisingly high levels of shock and vibration so it is a wise precaution to support all the major components like capacitors transistors and LEDs with an application of hot-melt glue after the circuit has been fitted and wired to the dynamo. Lastly fit the rear light lens and ensure that the LED is correctly aligned with the reflector lens opening.

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